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FACTS AND FALLACIES ABOUT DDT

H. H. STAGE
Bureau of Entomology and Plant Quarantine, Agricultural Research Administration
United States Department of Agriculture

Between May 1944 and the fall of 1945 one news clipping service piled up a total of over 20,000 items on DDT. Some of them contain factual statements on this marvelous and mysterious chemical, which when properly diluted or formulated becomes an exceedingly potent insecticide. Many of these items, however, gave the public incorrect impressions as to what DDT will do from a beneficial standpoint, and not a few cautioned the public against its sinister and unknown dangers. The following facts and fallacies may be useful in understanding just what the limits of DDT are as an insecticide and something of its toxicity to humans and animals, as well as its role in the insecticidal field.

A few months ago my cousin dashed into our house to inform me that a friend of a friend of a friend of hers had died of DDT poisoning. There was a certain sadistic satisfaction in her voice and manner, because for many weeks she had been hearing me tell of the wonders of this new insecticide. She was sure that DDT was responsible, for had not the victim shortly before death advised his wife to sue the company for damages?

I could not immediately refute my cousin's story, but I planned at once to get the facts. I knew Paul A. Neal, chief of the Industrial Hygiene Research Laboratory, National Institute of Health, was interested in every suspected case of DDT poisoning and that his office no doubt had inquired into this unfortunate incident. This is what Dr. Neal said:

"I may state that we traced this case and found that this man had only been exposed to DDT about one month prior to the onset of his illness, this exposure being that he was in a theater during its disinfection by commercial fumigators with a 5-per cent DDT oil solution.

"His exposure was *a priori* much less than the men who did the fumigating. Following this he took some of the solution left by the commercial fumigators and mixed this with Varsol and did quite a bit of spraying. He was under the impression that the solution left by the fumigators contained DDT, and since his illness began very soon after using this material it was natural that DDT poisoning would be suspected. However, an examination by this laboratory of the material he thought contained DDT failed to reveal DDT. A check with the fumigating company revealed also that it was Deobase and that they had left no DDT solution in the theater."

While on a trip to Chicago last fall W. E. Dove saw a suspected case of DDT poisoning in the Marine Hospital there. The victim was a professional man, a chemist. He complained of throbbing sick headache, marked tremor of the hands and weakened leg muscles, an erythematous rash, and nausea which in at least two instances was followed by temporary bleeding from the nose and throat. The tremor in his hands worried us. It looked like the real thing. We reported our information to Dr. Neal, and a physician from the Industrial Hygiene Research Laboratory was sent to Chicago to study the case.

The following is a summary of Dr. Neal's report:

"With the advent of DDT, the patient was assigned the task of determining its effectiveness as an insecticide. . . . Other than his periodic headaches, the patient had enjoyed good health until he started his experiments with DDT. During April, May, July, and August, he tested 5 per cent DDT, 3 per cent cyclohexanone, and kerosene solutions as residual sprays. At the beginning precautions were observed by wearing gloves, goggles, a handkerchief over the nose and mouth and coveralls. Later no precautions were observed. Prac-

tically every night after he had finished a test a throbbing sick headache and nausea were experienced. The other symptoms noted above were experienced from time to time. . . . After a careful physical neurological examination, supported by laboratory tests, the diagnosis and discussion of findings in part are as follows: Although the exact nature of the patient's recent acute illness is not known, its relation to DDT exposure is very doubtful. . . .

"There was no real evidence of liver, kidney, and nervous system injury such as might be expected from the experience gained from animals exposed to DDT. Based on the results of patch tests, the patient presented no evidence of sensitivity to DDT, cyclohexanone, or a combination of the two. As expected, the patient and the control subject had severe skin reactions to kerosene and xylol with and without the presence of DDT."

The report concluded, "There is strong evidence that his symptoms were due to one of the solvents, cyclohexanone, rather than DDT."

A number of persons heavily exposed to DDT solutions because of their jobs as sprayers have been examined thoroughly, according to Dr. Neal. His interviews with officers who have directed spraying crews using large volumes of DDT solutions reveal that occasionally some workers complained of transient upper respiratory irritation, headache, and nausea. These symptoms, however, were attributed to the solvents used, usually kerosene.

The following story appeared in a southern Florida newspaper on November 5, 1945:

"Cavalier Star Ill, Blamed on DDT Spray. DDT may stop insect-breeding, but the powerful spray is hatching a nest of trouble for Ponce de Leon's football team. For a doctor's diagnosis has cited 'allergy to DDT' the cause for the illness that kept high-scoring Dave McDonald sidelined for the Cavalier's last four games. Dave's wearing a gauze mask now to try to keep free of the stuff."

Of this incident our colleague, Fred H. Stutz, says:

"I talked to the doctor, one of four that seem to have treated the boy the greater part of the time he was indisposed. He advised me that DDT was not thought of or mentioned in connection with his disability. The boy, apparently, had a congestion in the head and inflammation of the sinuses. No doctor said DDT had anything to do with his condition. The father stated there was no proof or evidence that DDT was involved."

Yet according to the news article the coach was convinced that "if the city decides to spray again before Thursday, we're sunk." A new and interesting alibi for a football team's failure, but a fallacy as to the effects of DDT.

To these and many other stories of DDT injury the best reply we have is given by Dr. Neal in a letter to me dated December 26, 1945, "Up to this date no cases of DDT poisoning in humans in the United States have been found to be due to DDT *per se.*"

G. H. Bradley, chief of the Entomology Division, Malaria Control in War Areas, U. S. Public Health Service, wrote on December 27, 1945:

"On the MCWA operational program we have used over 300 tons of DDT in emulsions, solutions and dusts and have no authentic records of injury to humans caused by it. A few cases of dermatitis have been reported, none serious, presumably caused by workmen failing to use rubber gloves when mixing solutions. These probably were due to the solvent. Our men are instructed to use respirators when applying DDT. However, I think more of them work without than with respirators."

As far as I can learn, the following cases of DDT poisoning are the only authentic ones on record. The first case is that of a laboratory worker in England who deliberately rubbed into his skin strong solutions of DDT in a way that is not likely to happen in practice. Symptoms characteristic of DDT poisoning as revealed

by experiments on animals were produced, but recovery was gradual and complete.

The death due to DDT of a 19-months-old child of a West African soldier was reported in the British Medical Journal. The child died four hours after drinking approximately an ounce of 5 per cent DDT in crude kerosene. It is reported that the insecticide and not the kerosene caused the death, although the evidence given is open to question.

Lt. Col. O. R. McCoy, chief of the Tropical Disease Control Branch, Office of the Surgeon General, U. S. Army, has given me the following information on the death due to DDT poisoning of several natives on Okinawa. A native woman obtained a can containing DDT and, believing it to be baking powder or baking soda, used it for preparing fritters. These fritters did not rise quite so well as expected and she added a little more powder. Exact amounts were not known, or the number of fritters prepared or consumed. No one knew whether the powder was 100 per cent DDT or whether it was the DDT louse powder (10 per cent).

The total number of persons eating the fritters has not been determined, but about 35 consumers developed symptoms. The onset for severe cases was between 24 and 48 hours after ingestion, but others developed symptoms 3 to 5 days later. Extreme hyperesthesia of fingers and toes, with a sense of numbness, was the first thing noted. The feet became extremely tender and painful so that walking became impossible. There was no gastro-intestinal irritation, no nausea, vomiting, or diarrhea. These symptoms lasted for 1 or 2 weeks or longer.

Twelve of the victims suffered a progression of symptoms, became comatose and eventually died. Autopsies were performed on some of the fatal cases, and tissues as well as some of the fritters were sent to the U. S. Public Health Service for quantitative DDT determinations.[1]

[1] After the above was written it was learned that thallium, not DDT, had been found in the fritters and tissues submitted for quantitative analysis.

The toxicity of DDT in aerosols has been studied by P. A. Neal and W. F. Von Oettingen. Three years ago they exposed two human subjects for 1 hour on 6 consecutive days in a sealed chamber to 10.4 grams of an aerosol containing 5 per cent of DDT, 10 per cent of cyclohexanone, and 85 per cent of Freon. According to their report these tests "failed to show any subjective or objective manifestations referable to DDT." These workers also point out that the amount of DDT to which these two individuals were exposed was at least 10 times as great as would result from the household use of a single DDT aerosol bomb.

A year later one of these subjects was given 475 milligrams of DDT dissolved in olive oil by mouth on an empty stomach and a few months later 770 milligrams under the same conditions. Careful and thorough examinations have given no untoward effects from the ingestion of DDT in the manner described, according to Drs. Neal and Von Oettingen.

Since there is no specific antidote for DDT poisoning, the treatment has to be symptomatic. It is of paramount importance to prevent further absorption by removing any DDT from the skin by washing with soap and warm water or, in the case of ingestion, by removing it from the stomach by lavage with warm water or from the intestine by saline cathartics. Nervous manifestations, such as tremors and convulsions, experiments with animals by H. O. Calvery and coworkers in the Food and Drug Administration, indicate, can be controlled by phenobarbital, which, may prove lifesaving even in severe cases.

Interesting accounts of the poisoning of animals and wildlife, some of which are fallacious and unfortunate, have reached us.

On July 20 of last year the following telegram was received in our office: "We have valuable bull to which we applied spray of DDT in kerosene oil week ago. Now unable to stand up. Can you advise anything helpful?" The wire was answered by L. T. Giltner, of the Pathologi-

cal Division of the Bureau of Animal Industry:

"Experiments carried out by the Department have shown that a 900-pound cow may be given as much as 1⅓ ounces of DDT by mouth daily for 6 days without causing symptoms of poisoning. . . . In the case of your bull, it is possible that the kerosene, if used in considerable quantity over large areas of the body, may have caused severe skin inflammation as well as other symptoms of poisoning, including marked weakness and paralysis."

The bull died, apparently from oil poisoning, but DDT got the blame.

According to findings of several toxicologists, the symptoms of DDT poisoning in animals include hyper-excitability, nervousness, generalized tremors, clonic-tonic type of convulsions, and coma ending in death. The convulsions resemble closely those seen in strychnine poisoning, in that they can be elicited by mechanical stimuli, such as sudden noise and jarring. Technical DDT does not cause irritation of the skin in either animals or humans, nor is there definite evidence of a sensitizing effect on the skin or of other allergic reactions such as asthma. It should be emphasized, however, that certain solvents used in the preparation of DDT sprays and aerosols are in themselves skin irritants with sufficient exposure. It should also be emphasized that the symptoms produced by these solvents set in rather promptly, whereas symptoms produced by DDT develop only after several hours.

Wild ducks dying at the rate of about 200 daily in the Tampa Bay section of Florida last fall prompted considerable newspaper publicity. Local people attributed this loss to DDT poisoning, presumably because several weeks previously the bay had been sprayed with DDT as part of the local mosquito-control program. On January 7, 1946, Clarence Cottam, chief of the Division of Wildlife Research, Fish and Wildlife Service, wrote me, "We have been entirely unable as yet to determine the causes of this loss, but from evidence that I have seen I am convinced DDT poisoning was not responsible."

I am confident, however, that injudicious use of DDT has been responsible elsewhere for the loss of wildlife.

Last summer I witnessed the treatment by air of a peninsula several miles long and a few hundred yards wide. Mosquitoes were very annoying in the area, and immediate control measures were desired. A 20-mile wind was blowing from the west, and in order to make sure of adequate coverage along the western margin of the peninsula the pilot flew over it repeatedly, releasing several times the intended dosage of ½ pound of DDT per acre. The westerly wind also piled up along the shore line the DDT spray that had fallen on the waters of the bay. There is no doubt, therefore, that the concentration of DDT along the western shore was heavy.

No dead birds were observed, but 3 days later an estimated 100,000 small dead fish, menhaden, mullet, and killifish were seen along the entire shore line. This is an example of harm that can be caused when reasonable precautions are not taken. When aircraft is used for dispersing DDT, the velocity of the wind is an important factor in putting the spray where it is needed and in the amount recommended —about 0.1 pound per acre.

Workers in the Bureau of Entomology and Plant Quarantine have determined that livestock can graze in pastures sprayed or dusted with DDT in dosages as high as 2 pounds per acre without apparent injury. However, when 2 horses, 2 sheep, 2 goats, and 2 cattle were pastured in vegetation treated with 7½ pounds of DDT per acre, after the sixth day the cattle gave signs of stiffness which became severe. The other animals did not seem to be affected. At the end of the test the animals were moved to clean pasture and the cattle recovered fully in a week's time.

The practice of grazing milk cattle on areas treated with DDT, however, is hazardous for another reason. It has been shown that when DDT is ingested by milk cows as much as 3 parts of DDT per million can be reclaimed from the

milk. Flies and rats have been killed by feeding on milk produced by cows fed DDT, and nursing pups have been killed by feeding DDT to the mothers.

Apparently DDT dusts or water-dispersible DDT in suspensions can be dusted and sprayed on livestock without absorption or injury. We do not recommend the use of oil sprays or DDT in oil sprays on livestock.

The following account in the Florida Cattleman of reducing a population of horn flies on cattle is so incredible that it may be well to report it here as a fact:

"Orange County, Florida, raises cattle, lots of them. Last July and August a plague of horn flies hit the ranches. The cattle bunched up for protection, stood belly-deep in streams for hours, and couldn't eat or rest properly. Calves were starving because the cows couldn't stand still. W. G. Bruce, an entomologist in the Bureau of Entomology and Plant Quarantine, thought the situation would provide an ideal experiment. Seventy ranchers who own almost all the cattle in the 350-square-mile County signed up for the test. Over 25,000 cattle were sprayed or dipped and over 200,000 square feet of dairy-barn and stable surface were sprayed. Results were immediate and spectacular. Within 2 days only 2 or 3 flies could be found where some 4,000 horn flies had pestered each cow before the test."

Although we have had second- or third-hand reports of dogs killed by treatment with DDT, our entomologists have observed no injury to 45 dogs receiving a total of more than 200 treatments in flea and dog tick control tests. These animals have been dipped in 5 per cent of DDT in benzene emulsion, in 1 per cent of DDT in pine oil emulsion, in 1-per-cent water-dispersible DDT suspension, and have been dusted with 10 per cent of DDT in pyrophyllite or talc.

Cats on the other hand, have been killed when dipped in 5-per-cent DDT emulsions or treated with 10-per-cent DDT dusts.

DDT has not been found more effective than derris wash for the control of ticks on dogs, and we still prefer derris for this purpose.

When fish are involved, extreme caution should be exercised in the use of DDT. For mosquito control we suggest the use of less than ½ pound of DDT per acre in an oil solution to avoid injury to fishes, crabs, and crayfish. This dosage is sufficient to control mosquito larvae and adults under most conditions. Preliminary tests have indicated that emulsions are most toxic to fish, solutions next, and suspensions considerably less so. We also recommend using DDT only in calm, dry weather, so that coverage can be controlled and overdosage reduced to a minimum.

We have called DDT the perfect answer for the bedbug problem. It is very effective against adult flies but not against their larvae. When thoroughly applied it gives great promise in the control of most other insects affecting the household such as brown dog ticks, silverfish, carpet beetles, clothes moths, and cockroaches. DDT solved the body louse problem, and consequently knocked out typhus in World War II. It is the most effective insecticide known against the Japanese beetle, but it is of little use against the cotton boll weevil, the Mexican bean beetle, the cattle grub, the screwworm, chiggers, the sugarcane borer, the cotton leafworm, red spiders, and certain scales.

Information to date indicates that when used in recommended amounts it does not affect most plants although it does injure squash and related species. However, when used at the rate of 25 pounds per acre, it has been found to retard the growth of some kinds of vegetables and flowering plants. Workers in the Bureau of Plant Industry, Soils, and Agricultural Engineering are also testing the effect of DDT on the growth of several kinds of field crops.

The chemical DDT alone is not suitable for use as an insecticide. It should only be used in greatly diluted formulations. For example, a 10-per-cent dust is the highest concentration of any DDT product recommended for final use

whereas 5 and 2.5 per cent and even lower strengths are recommended for sprays. DDT insecticides are now available in several forms—in aerosols, in solutions, in concentrates for use in preparing emulsions, in water-dispersible powders for use in suspensions, and in dusts. Of these forms, the water-dispersible powders are probably the most practical and safest for use on livestock and around farm buildings. Within homes a greaseless refined kerosene containing 5 per cent of DDT is preferred for use as a residual spray.

Purchasers should insist that the preparations they buy show the DDT content. Some labels describe the contents as 100 per cent active, but the contents can be 99.9 per cent of kerosene and 0.1 per cent of DDT without violating the law.

There is some evidence that temperature has a marked influence on the effectiveness of DDT. Unlike many other insecticides, the chemical is more effective at low temperatures than at high temperatures, at least, against some insects.

We have had many reports of unsatisfactory results from the use of DDT. In most of these instances the insecticide was haphazardly used. The householder did not differentiate between its value as a space spray and a residual spray, or the spray contained too little DDT or none at all.

While in Mexico last September I saw a bottle the label of which read "Contains DDT." The material, however, failed to kill bedbugs, and if bedbugs are not killed with this insecticide something must be radically wrong. The contents were, therefore, analyzed and no trace of DDT was present. No doubt other examples of this kind are known.

Within 5 years DDT has risen from an obscure chemical curiosity to one of our most efficient insecticides—when properly applied to the proper insect. And this, of course, is true of all insecticides. DDT should never be considered as a general all-purpose spray. It must be used wisely and according to directions. In the absence of such directions, it is preferable to use other standard insecticides.

In citing these facts and fallacies, we do not wish to minimize the hazard of using the chemical. It is a poison, and it is toxic to man, but it is not so dangerous as lead arsenate, paris green, sodium fluoride, and some other insecticides that are in common use. The experience of the Bureau of Entomology and Plant Quarantine, the Public Health Service, and the Rockefeller Foundation, the extensive use of large quantities by the armed forces all over the world, and experimental work on animals by the Food and Drug Administration and the National Institute of Health have shown that it can be used safely if properly labeled, if properly applied, and if reasonable precautions for poisons are followed.

Fortunately for us who are interested in controlling *Anopheles* mosquitoes and malaria, DDT offers an entirely new and economical method of attack. I refer to its use as a residual spray to the interior surfaces of native homes. When used in this manner it kills the anopheline without injury to other life.

OUTDOOR CONTROL OF ADULT MOSQUITOES WITH DDT OR PYRETHRUM APPLIED WITH GROUND EQUIPMENT[1]

A. H. MADDEN, ARTHUR W. LINDQUIST, B. V. TRAVIS, AND E. F. KNIPLING[2]
U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine

Prior to recent developments in the use of DDT (1-trichloro-2, 2-bis [*p*-chlorophenyl] ethane) as an insecticide, the outdoor control of adult mosquitoes received little attention. Ginsburg (1935) reported the use of pyrethrum spray for the protection of public gatherings, and in 1943 Latta and Wilson investigated the use of pyrethrum aerosols and smokes against adult mosquitoes in the open (Stage 1945).

In 1943 and 1944 extensive tests were conducted at the Orlando, Fla., laboratory of the Bureau of Entomology and Plant Quarantine with dusts, sprays, and liquefied-gas aerosols containing DDT or pyrethrum against adult mosquitoes in their natural habitats. All treatments were applied with ground equipment. The purpose of these tests was to determine the possibility of obtaining immediate though temporary relief by the use of such methods, which, if effective, would be helpful to troops bivouacking in mosquito-infested jungles and other areas. Information gained from these studies also served as a basis for more extensive studies by this laboratory and various agencies using other types of ground equipment and aircraft. Studies on the prolonged effectiveness against adult mosquitoes of single applications of DDT to jungle vegetation are discussed in another paper (Madden *et al.* 1945).

The greater portion of the investigations discussed in this report were conducted under jungle conditions. Results were evaluated by counting the mosquitoes landing per minute on the front of the trousers.

Dust Treatments.—During August 1943, 18 field tests against adults of the salt-marsh mosquitoes *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Walk.) were made in the daytime near Cocoa, Fla., with dusts consisting of various concentrations of DDT in talc. Treatments were applied with rotary hand dusters, to square plots from ¼ to 10 acres in size, by crossing and recrossing the plots in swaths approximately 20 feet wide. The plots were located under a high canopy of cabbage palmetto and oaks, with an undergrowth of thick, low-hammock vegetation mixed with dense clumps of saw palmetto.

Results are given in Table 1. The percentage control is based on counts made 3 to 4 hours after treatment. Observations indicated that the reduction in mosquitoes recorded at that time persisted throughout the remainder of the day, largely because the salt-marsh species do not move about

TABLE 1. Control of adult salt-marsh mosquitoes with dusts consisting of various concentrations of DDT in talc. 1943.

Concentration of DDT	Amount of DDT per Acre	Size of Plot	Control after 3 to 4 Hours
Per Cent	*Pounds*	*Acres*	*Per Cent*
50	4	¼	100
20	1	1	90
		1	99
50	.5	1	83
		1	93
5	.25	1	93
		1	95
10	.23	10	97
20	.2	1	99
		1	93
10	.1	1	99
		1	91
5	.05	1	80
		1	92
1	.035	1	97
	.025	1	71
	.024	10	81
Check (talc 5 lb.)	0	1	1

[1] This work was conducted under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

[2] The assistance and advice of Howard A. Jones on the chemical aspects of the problem is acknowledged.

to any great extent in daylight. The reduction of mosquitoes was highly satisfactory and ranged up to 100 per cent. Although residual effects were not expected, a few observations showed that the residue from higher dosages gave good control up to 10 days.

Since control with DDT dusts appeared impractical from a military standpoint, as it is difficult to prepare them in the field and to keep them in perfect physical condition for proper delivery, testing with the insecticide in this form was discontinued after the completion of these tests.

Spray Treatments.—Tests with finely atomized sprays against salt-marsh mosquitoes were conducted in the same area and under the same conditions as the tests with dusts. Solutions containing various concentrations of DDT were applied with a paint sprayer connected with a hand-power pressure tank. Treatments were applied in 20-foot swaths as in the dust tests. The nozzle was held about 4 feet above the ground and directed in such a way as to take advantage of any air movement in order to drift the spray as far as possible. The results are presented in Table 2. It will be noted that good reduction was obtained with as little as 5 grams of DDT per acre. No increase in effectiveness was obtained with dosages above 50 grams per acre. As was expected, little or no residual effect was demonstrated. Kerosene alone gave some control.

In the summer of 1944 tests were continued in the same area with treatments involving 10 to 20 per cent of DDT but much smaller amounts of total solution, since the 1943 tests had shown that the dispersion of even a liter per acre involved a great amount of pumping to provide the large quantity of air needed for atomization. Furthermore, if limited amounts of liquid could be used effectively, the supply problem, which is an important factor under military conditions, could be alleviated materially. In these tests (Table 2) excellent control was obtained with as little as 67 ml. of total solution per acre. Because of the higher concentrations, however, more DDT was applied in this small amount of liquid than with 240 ml. of a solution containing 5 per cent of DDT.

In a series of eight tests concentrated sprays containing either DDT or pyrethrum were compared. Each solution was

TABLE 2. Control of adult salt-marsh mosquitoes with finely atomized sprays containing various concentrations of DDT in different diluents.

Diluent	Concentration of DDT	Total Spray per Acre	Amount of DDT per Acre	Size of Plot	Control after— 1 Hour	3 to 4 Hours	24 Hours
	Per Cent	*Milliliters*	*Grams*	*Acres*	*Per Cent*	*Per Cent*	*Per Cent*
Solutions:			TESTS IN 1943				
Cyclohexanone	50	500	250	1	....	99	....
Kerosene	5	1,000	50	1	....	99.7	61
			200	¼	....	99.4	....
	.5	1,000	5	1	....	85	51
Aqueous emulsion [1]	5	1,000	200	¼	....	96	....
Check (kerosene)	0	1,000	0	1	....	41	32
			TESTS IN 1944				
o-Dichlorobenzene	10	240	24	1	97	....	....
		140	21	⅔	92	....	....
Cyclohexanone 20% Motor oil 5% Kerosene 55%	20	67	14	¾	93	....	....
No. 2 fuel oil	5	240	12	1	95	....	....

[1] Made from a concentrate containing 25% of DDT, 7% of *Triton X-100* (an aralkyl polyether alcohol), and 68% of xylene.

tested four times on each of two 1-acre plots, the treatments being alternated between plots in order to eliminate any error due to possible physical differences in the plots. The DDT spray contained 10 per cent of DDT plus 10 per cent of cyclohexanone, and the pyrethrum spray 0.75 per cent of pyrethrins plus 5 per cent of motor oil (S.A.E. 30) in kerosene. Both solutions were applied at the rate of 240 ml. per acre. This dosage contained 24 grams of DDT and 1.8 grams of pyrethrins. The average control 1 hour after treatment was 94 per cent with both treatments. The pyrethrum spray gave control almost immediately after application, but the action of the DDT spray was somewhat slower, requiring about 20 minutes to produce the same results.

Satisfactory control over a large area with a limited amount of material is dependent not only on a high concentration of the insecticide but also, and perhaps to a greater degree, on the type of equipment used. For best results a nozzle must be used that will break the material into a large number of fine particles. A laboratory study of the particle size of the spray produced by the nozzle used in these tests showed an average diameter of 18 microns when a solution containing 5 per cent of DDT in kerosene was discharged at about 25 pounds per square inch pressure. This is somewhat larger than the particle size produced by certain nozzles now available, but it appears to have been satisfactory for all practical purposes. The optimum particle size for use under all types of conditions is still undetermined.

A limited number of exploratory tests were made with a power sprayer mounted on a jeep. This equipment was tested with and without an air blast behind the nozzle. The air blast was produced by a 24-inch wooden propeller rotating inside a sheet-metal collar 6 inches deep, which served to direct the air movement forward. Both the propeller and the compressor were operated by a 7-horsepower gasoline engine. The results indicate that a maximum effective swath width of about 100 yards is all that can be expected with such equipment, either with or without the air blast. This does not appear sufficient to balance the difficulties involved in maneuvering such equipment through the jungle, although it may be useful in relatively open areas.

Aerosol Treatments.—The effectiveness of outdoor applications of liquefied-gas aerosols also was studied. Preliminary tests against salt-march mosquitoes were conducted in 1943 at Cocoa, in the same manner and under conditions identical with those in the dust and spray tests. Both DDT and pyrethrum aerosols, with *Freon-12* (dichlorodifluoromethane) as the propellant gas, were dispersed from standard 1-pound Army containers, or "bombs," carried on sticks about 8 inches from the ground and applied in 20-foot swaths. The results presented in Table 3 show that the contents of one of these bombs, whether pyrethrum or either DDT formula, gave from 91 to 100 per cent control over an acre of jungle. Biting stopped almost immediately with pyrethrum and within a few minutes with DDT. As in the dust and spray tests, treatments were

TABLE 3. Control of adult salt-marsh mosquitoes with liquefied-gas aerosols containing either pyrethrum or DDT. 1943. (1-acre plots unless otherwise indicated.)

Aerosol	Total Amount of Aerosol Per Plot	Amount of Active Ingredient Per Acre	Control after 3 to 4 Hours
	Grams	*Grams*	*Per Cent*
Pyrethrum (0.4% pyrethrins) + sesame oil 8%	331	1.32	98
	500	2.0	97
	500	2.0	99
	2,461 [1]	1.56	95
	136	.54	95
DDT: 5% + cyclohexanone 10%	450	22.5	91
	450	22.5	95
	450	22.5	99
	264	13.2	75
25% + dibutyl phthalate 25%	520 [2]	130.0	100

[1] 6⅓ acres treated.
[2] ¼ acre treated.

applied during the daytime and the plots remained practically free of mosquitoes until after dark.

A limited number of tests of pyrethrum and DDT-pyrethrum aerosols were conducted in the jungles of Panama in 1944. Applications were made in the same manner and at the same rate as in Florida, but at night. Complete control of *Mansonia* spp. and *Anopheles albimanus* Wied. was obtained for at least 1 hour.

During the summer of 1944 further tests were made of aerosols in 10- to 50-pound containers. The objective was to produce a large volume of aerosol at a fixed point and determine the control obtained as the cloud moved downwind. Methyl chloride was used as the propellant gas since it is safe toxicologically under outdoor conditions, is a better solvent for DDT, and is less expensive than *Freon-12*.

Preliminary tests were conducted on the open salt marshes near Cocoa. Applications were made early in the morning while the ground was still cool and the air movement was horizontal. The aerosols were discharged with a nozzle consisting of a ¼-inch copper tube about 18 inches long having 15 holes on one side, each 0.017 inch in diameter. When 1,464 grams of an aerosol containing 2 per cent of pyrethrins, 15 per cent of motor oil (S.A.E. 30), and 25 per cent of kerosene was discharged over a 90-foot front, complete control of mosquitoes for 600 feet of the marsh and an additional 200 feet into the jungle was obtained within 10 minutes. Comparable tests were made over about 15 acres of marsh with two formulas—(1) 20 per cent of DDT, 10 per cent of cyclohexanone, 5 per cent of motor oil (S.A.E. 30), and 65 per cent of methyl chloride; and (2) 20 per cent of DDT, 10 per cent of cyclohexanone, 30 per cent of kerosene, 5 per cent of motor oil (S.A.E. 30), and 35 per cent of methyl chloride. In each case 6,000 grams of aerosol was discharged over a 400-foot front. Formula (1) gave a reduction of approximately 75 per cent of mosquitoes up to the edge of the jungle, a distance of 1,200 feet, in less than 10 minutes. At the end of 1¼ hours there was 90 to 95 per cent control over the entire area. Formula (2) produced a coarse spray instead of an aerosol, and no control was obtained even 100 feet from the point of discharge as late as 40 minutes after treatment.

Formula (1) was tested again by discharging 15,890 grams of the aerosol from a boat, along a 1,000-foot front at the edge of a square mile of open marsh. The nozzle consisted of 10 copper tubes, 1 inch long and 0.040 inch inside diameter, fastened at right angles to a ¼-inch copper tube. Complete control of mosquitoes was obtained up to 1,500 feet downwind. Two additional tests were made with the same formula to determine the relative efficiency of two different nozzles. In each test 6,000 grams of total aerosol was discharged along a 400-foot front. In one test the ¼-inch tube with the 15 holes, previously described, was used, and in the other test a ¼-inch tube with 10 capillary tubes ¾-inch long and 0.017 inch in diameter attached to one side. The 15-hole nozzle gave an over-all control of 78 per cent up to 1,200 feet, whereas the capillary-tube nozzle gave 75 per cent control for only 100 feet. These results indicate that the type of nozzle plays an important part in the results obtained.

Further tests with aerosols were made on rice-stubble field near Stuttgart, Ark., against adults of *Psorophora* spp. Satisfactory kill was obtained for only 175 to 400 feet. The poor drift is attributed to the type of nozzle used, which consisted of a ⅜-inch copper tube with a series of holes 0.030 inch in diameter drilled in one side.

Although rather outstanding control was obtained in a number of the tests in Florida, the use of aerosols in the open has given in general rather erratic results. Apparently, as with the sprays and dusts, the best results can be obtained under jungle cover or similar sheltered places, when the air movement is not strong enough to remove the treatment before it has a chance to kill. Advantages obtained by greater drift over open areas are uncertain. It is probable that the con-

dition of the atmosphere and characteristics of the terrain were important factors in some of the tests.

Discussion.—In general, the results of the investigations with DDT and pyrethrum applied with ground equipment were very striking. Although the use of hand equipment requires a great amount of labor, it is a practical means of protecting personnel in bivouac or other restricted areas from mosquitoes. The application of DDT and pyrethrum sprays and aerosols in this manner was recommended to the armed forces as early as 1943. The use of power sprayers mounted on ground vehicles may be practical under conditions where terrain will permit.

The information gained from these experiments has also served as a basis for more extensive studies utilizing other equipment, such as airplanes. The results demonstrated that very small amounts of either DDT or pyrethrum were required to control adult mosquitoes. It was encouraging and highly significant that over 90 per cent reduction of adult salt-marsh mosquitoes was obtained at dosages as low as 0.05 and 0.025 pound per acre. Since it was known that adult mosquitoes could be controlled with very low dosages, studies with aircraft were considered essentially a problem of developing suitable equipment and methods of controlling the spray so that it would reach the mosquitoes.

Summary.—Outdoor tests with dusts, sprays, and aerosols containing DDT or pyrethrum as a method of temporary control of adult mosquitoes were conducted in 1943 and 1944. Dusts applied at rates from 0.035 to 4 pounds of DDT per acre gave good control of adult salt-marsh mosquitoes (*Aedes taeniorhynchus* [Wied.] and *A. sollicitans* [Walk.]), but for practical use they are considered less satisfactory than sprays. Sprays applied at the small dosage of 12 grams of DDT (0.025 pound) per acre, with a concentration requiring only about 240 ml. of liquid or less, gave nearly complete reduction of mosquitoes when atomized properly with a paint-sprayer nozzle and applied in 20-foot swaths. Similar results were obtained with sprays containing 0.75 per cent of pyrethrins applied at the rate of 1.8 grams of pyrethrins (0.004 pound) per acre. Limited tests indicated that heavy power equipment was not sufficiently better than hand equipment to warrant its use in jungle areas. The contents of a standard 1-pound aerosol container applied in the same manner as the dusts and sprays, with the container held about 8 inches from the ground, was found to be sufficient to give 91 to 100 per cent control over an acre of jungle. The aerosols were also effective against *Mansonia* spp. and *Anopheles albimanus* Wied. in Panama. DDT and pyrethrum aerosols were about equally effective. Pyrethrum gave almost immediate control in both sprays and aerosols, while DDT was somewhat slower, producing the same results in about 20 minutes. Large amounts of aerosol discharged at one point and drifted downwind gave conflicting results in open areas.

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MOSQUITOES AND OTHER INSECTS KILLED BY AERIAL SPRAYING WITH DDT IN PANAMA

H. H. STAGE
U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine

Aerial spraying with DDT for mosquito and other insect control has aroused much speculation as to its effect on local insect populations. Information of this type is desirable because it is possible that beneficial insects as well as injurious forms may be killed. Biological deserts may be produced by heavy treatments of DDT, and these, of course, will be highly undesirable. In fact, any upset in the balance of nature is liable to produce conditions unfavorable to the general welfare of the plants and animals present. If, for example, insects are eliminated from a large area, young birds may subsequently starve. A wise program of control always considers all factors involved and should not be imposed without regard to the end result.

Undoubtedly in the future large areas will be treated with DDT as a control agent against mosquitoes, flies, forest insects, and other injurious species. This report is one of the first to shed light on the number of species affected by DDT sprays when used over large areas for the control of mosquitoes. Unfortunately, few specimens could be determined as to species, either because they had been damaged or because of lack of knowledge of the Panamanian insect forms.

During airplane-spraying tests in tropical jungles of Panama by the U. S. Navy in December 1944, and by the U. S. Army in January–February 1945, several observations and collections were made of insects affected by DDT mosquito sprays by entomologists [1] working under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

The Navy tests were made with a Navy TBM airplane equipped with a specially constructed exhaust generator. The droplets produced measured less than 75 microns in diameter. The spray was made of 20 per cent of DDT in Velsicol NR-70 (aromatic petroleum fraction) and was applied at the rate of 0.36 pound of DDT per acre over an area of approximately 1 square mile.

The Army tests were made with a B-25 and a C-47 airplane equipped with a gravity-feed straight-stack or a grid exhaust dispenser designed by Army engineers. The droplets produced were 300 to 150 microns and less in diameter. The following sprays were tested: (1) 5 per cent of DDT in No. 2 fuel oil; (2) 10 per cent of DDT and 20 per cent of polymethylnaphthalene auxiliary solvent (K-237) in No. 2 fuel oil; (3) 5 per cent of DDT and 10 per cent of lubricating oil (S.A.E. 30) in No. 2 fuel oil; and (4) a 5-per-cent DDT aqueous emulsion prepared from a concentrate consisting of 25 per cent of DT, 10 per cent of Triton X-100 (aralkyl polyether alcohol) and 65 per cent of xylene. These sprays were applied at the rate of 0.3 to 0.6 pound of DDT per acre.

Immediately before or after treatment bed sheets (4 by 7 feet) were spread on the ground (fig. 1) under heavy, medium, and light jungle canopy. Insects began falling on the sheets about 15 minutes after treatment and continued falling in varying numbers for the next 24 hours. These specimens showed characteristic DDT poisoning.

Casual observations of the insect populations in the jungle indicated no apparent difference in numbers of insects or species before and after treatment. Occasionally

[1] A. W. Lindquist, C. C. Deonier, E. F. Knipling, C. B. Wisecup, A. H. Madden, and the author.

Fig. 1. Bed sheets were laid on the ground for the collection of insects killed by DDT aerial spraying.

large Lepidoptera and Hymenoptera showing characteristic DDT poisoning were seen on the ground soon after treatment, but no reduction could be observed in the numbers of active insects, other than mosquitoes, from day to day.

Most of the species were represented by only 1 to 5 specimens each; but in the Diptera various species of Calliphoridae, Sarcophagidae, Tylidae, and Culicidae were obtained in much larger numbers. More than 50 individuals were recovered of each of several species and over 200 individuals of one species of mosquito.

The numbers of species [2] by order are listed:

Coleoptera: 53 species, including 12 species of flatheaded borers and 16 species of weevils.

Diptera: 148 species, including 10 species of blowflies.

Hymenoptera: 45 species, including 22 species of ants.

Hemiptera: 26 species.

Lepidoptera: 7 species.

Thysanoptera: 1 species.

Spiders and pseudoscorpions: several species.

[2] All species were identified by specialists of the Division of Insect Identification, Bureau of Entomology and Plant Quarantine.

DDT APPLIED WITH HAND EQUIPMENT FOR THE CONTROL OF SALT-MARSH MOSQUITO LARVAE[1]

C. B. WISECUP
U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine

AND

V. S. MINNICH AND W. C. WHITE
East Volusia County (Florida) Mosquito Control District

The development of DDT sprays for the control of various anopheline and culicine mosquito larvae (Deonier *et al.* 1945, Eide *et al.* 1945, Wisecup *et al.* 1945b) led to the study of such sprays for the control of larvae of the salt-marsh mosquitoes *Aedes sollicitans* (Walk.) and *A. taeniorhynchus* (Wied.). In 1943 Eide *et al.* (1945) found that an aqueous emulsion containing 0.05 part per million of DDT was completely toxic to natural infestations of mixed broods of these species when the DDT was thoroughly stirred in the water, and that DDT dusts were ineffective as a surface treatment unless heavy applications were made.

In 1945 a series of tests was conducted in which larvicidal treatments of DDT were sprayed on transient pools in roadside ditches, shallow ponds, marshes, and grassy swales for the control of these mosquitoes along the east coast of Florida. Several types of sprays were used—oil solutions, aqueous emulsions, and suspensions. Owing to the frequent heavy rains which occur in Florida during the summer rainy season, many pools containing grasses and also many roadside ditches were found which could be readily treated. All these areas were small enough to be covered by hand application, and could be traversed by a man wearing boots. Frequently the larval populations were tremendous.

Agitation of the water was inexpedient because of the excessive vegetation in these areas. A few preliminary tests showed that the drifting of hand-applied sprays, as was advocated for the control of *Anopheles* larvae (Wisecup *et al.* 1945a), was not applicable to the heavy vegetation which was usually present in these areas. However, it was observed that by crossing a breeding area at 30-foot intervals, direct application of sprays could be made.

The fuel-oil sprays were prepared by dissolving 2.1 pounds of DDT in 5 gallons of No. 2 fuel oil for a 5-per-cent concentration of DDT, and this mixture was diluted to give 2.5 and 1 per cent concentrations. These sprays were applied at dosages ranging from 1.2 to 0.2 pound of DDT per acre. The aqueous emulsions, containing 5 and 2.5 per cent of DDT, were made by adding water to a basic concentrate consisting of 25 per cent of DDT, 65 per cent of xylene, and 10 per cent of Triton X-100 (polyethyleneglycol alkyl aryl ether), and were applied at dosages ranging from 1.0 to 0.2 pound of DDT per acre. A few tests were made with water-dispersible 1 per cent DDT powders in an aqueous suspension applied at dosages ranging from 0.5 to 0.2 pound of DDT per acre.

The applications were made with a Chemical Warfare Service decontamination-type spray cylinder equipped with a garden-type nozzle having an aperture of No. 56 wire-gage size. At a pressure of 40 pounds per square inch this equipment discharged a gallon of liquid in 5 to 8 minutes, the time depending on the viscosity of the spray material.

Results.—A summary of the tests made in 1945 is presented in Table 1.

[1] This work was conducted under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

Table 1. Summary of tests for the control of salt-marsh mosquito larvae with various DDT sprays applied with hand equipment to transient pools.

Type of Spray and Concentration of DDT	Dosage of DDT	Area Treated		Average Larvae		
				Before Treatment	After Treatment	Control
Per Cent	*Pounds Per Acre*	*Square Feet*	*Cover*	*Number*	*Number*	*Per Cent*
No. 2 fuel oil						
1	0.2	21,780	Grassy	25	0	100
	.5	17,000	Grassy	100	0	100 [2]
	1.2	1,500	Grassy	50	0	100
2.5	.2	7,260	Open	25	.04	99 [2]
		5,000	Open	100	0	100
	.5	250	Open	3	0	100 [2]
5	.2	300	Open	25	0	100
	.4	10,890	Grassy	45	5	89 [2]
	.5	300	Open	25	0	100
		9,000	Thick spike grass	50	4	92 [1]
		43,560	Grassy	3	.01	99 [2]
	.8	10,890	Grassy	50	5	90 [1]
		43,560	Grassy	150	0	100
Aqueous emulsion						
2.5	.2	12,600	Open	19	0	100
	.5	940	Grassy	10	.04	99.6
5	.2	300	Open	25	0	100
	.4	10,890	Grassy	50	5	90 [1]
	.5	600	Open	25	0	100
	.8	10,890	Grassy	50	5	90 [1]
Aqueous suspension [4]	1.0	1,000	Open	25	0	100
1	.2	650	Open	5	0	100
		4,000	Grassy	100	.06	99 [2]
	.5	2,160	Open	50	.02	99 [2]
	.2	1,800	Open	3	.7	77 [2, 3]
	.4	21,780	Grassy	35	.5	98

[1] Pupation had commenced at time of treatment.
[2] Large populations on subsequent floodings. No residual control.
[3] Poor application due to clogging of equipment.
[4] Made from different lots of water-dispersible DDT.

Highly satisfactory control of these larvae was secured with all concentrations of DDT in both fuel oil and the aqueous emulsions. Excellent results were obtained with the aqueous suspensions, despite a tendency for the sprayer to become clogged with even this dilute mixture.

There were some indications that an application early in the season might prevent or retard breeding within an area, but this lack of breeding may have been due to natural causes. In eight test areas subsequent heavy breeding definitely showed that retreatment would be necessary.

Discussion.—In these tests 0.2 pound of DDT per acre gave perfect control of salt-marsh mosquito larvae, but the thoroughness with which the application was made was of paramount importance. By using 30-foot swaths it was possible to cover 1 acre with 1 gallon of spray. Therefore, to secure complete coverage of the entire area it was necessary to dilute the materials to 2.5 per cent or less of DDT. The occasional larvae which survived an application were always in sheltered areas of heavy vegetation.

DDT was no more effective against pupae of these species than against the pupae of other mosquitoes, even at a dosage of 0.8 pound per acre. Treatments

should not be delayed too long because of the rapid development of these species from egg to adult within a week.

The use of DDT will greatly simplify the supply problem for mosquito-control districts. Instead of the 10 or more gallons of oil per acre usually required to control these pests, a gallon of oil containing 2.5 per cent of DDT will be sufficient. Since some of the laborers employed for this purpose may not be so efficient as others, adequate coverage may not be obtained with this amount. In such cases good control can be obtained by diluting the mixture further and applying more spray material.

The smaller quantity of spray material required for control when DDT is used, plus the shorter time necessary for application, will permit the utilization of more man-hours for larval surveys during the short development period of these insects. It should now be possible for a control operator to carry both a dipper and a light knapsack sprayer filled with DDT solution. With this equipment immediate treatment can be made in breeding habitats that are found in areas where access is difficult. This will permit the finding and treatment of many small breeding areas which have been overlooked heretofore. These areas frequently are within or adjacent to inhabited areas, and no doubt have been responsible for the production of large numbers of these pests.

Summary.—Various forms of DDT were applied as larvicides to transient pools in roadside ditches, shallow ponds, marshes, and grassy swales for the control of the salt-marsh mosquitoes *Aedes sollicitans* (Walk.) and *A. taeniorhynchus* (Wied.) along the east coast of Florida during the summer of 1945. An application of 0.2 pound of DDT per acre in an oil solution or in an aqueous emulsion or suspension gave satisfactory control of these pests when the treatment was made before they began to pupate.

Hand treatment by means of a decontamination-type spray cylinder required the application of at least 1 gallon of material per acre to secure adequate coverage, which necessitated using a spray containing 2.5 per cent or less of DDT.

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QUICK-BREAKING FUEL-OIL EMULSIONS CONTAINING DDT [1]

PAUL M. EIDE, CHRISTIAN C. DEONIER, AND EDWARD NOTTINGHAM
United States Department of Agriculture, Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

Some difficulty has been encountered in getting proper dispersal of the small quanties of DDT-oil solutions necessary to give control of anopheline larvae when ground equipment has been used. One quart of fuel oil containing 5 per cent of DDT has been found to be ample for treating 1 acre of breeding area containing the average amount of vegetation (Deonier *et al.* 1945), but with the spray equipment in general use it has not always been possible to get satisfactory coverage. One method suggested for obtaining proper distribution of the larvicide was the use of emulsion concentrates diluted with water from the breeding places, thus increasing the quantity of spray material to be applied. Several series of tests to study the last method were conducted in Florida.

Materials and Methods.—In the first series of tests various emulsifiers (2 per cent) were added to No. 2 fuel oil in which 5 per cent of DDT had been dissolved. This solution was diluted with various quantities of water, and the resulting emulsions were applied at various dosages and quantities of spray.

Drainage ditches covered with water hyacinths (*Eichhornia crassipes* [Mart.] Solms) provided areas of uniformly high *Anopheles* breeding. These ditches were divided into small plots 100 feet long, with untreated buffer areas 50 feet long between each plot. The rankness of growth of the water hyacinth varied. Larval populations were determined by dipping just before the treatment was applied and again 24 hours later. Checks of larval populations were also made in several buffer areas to determine the reduction due to natural causes.

Applications were made from a cylindrical hand sprayer equipped with a boom 10 feet long and a spray nozzle with a No. 56 wire gage orifice. The sprays were usually applied directly to the plots, with no fogging or drifting. The water for dilutions was secured either from the ditch or from artesian wells nearby. All the materials were sufficiently emulsified for application by merely shaking the spray cylinder.

In the second series of tests 1 part of an emulsion concentrate containing 25 per cent of DDT and various emulsifiers was diluted with 4 parts of fuel oil and applied at a dosage of 0.1 pound of DDT per acre. A pipette was used to make the application. These tests were made on small chara-filled pools to observe the effects of the emulsifier in spreading the oil.

A series of practical tests was made to determine the effect of a quick-breaking emulsion on larvae of *Culex quinquefasciatus* Say breeding in a 2-acre lake covered with water hyacinth and polluted with sewage. The lake had previously been treated unsuccessfully with DDT in oil. The quick-breaking emulsion was made by mixing 1 gallon of concentrate (25 per cent of DDT, 10 per cent of Triton X-100, and 65 per cent of xylene) with 4 gallons of No. 2 fuel oil and adding 12 gallons of water. The material was applied from the shore of the lake with a portable orchard sprayer at a pressure of 400 pounds per square inch.

With the preparations used in these tests it was possible to obtain thorough distribution of the low dosages of DDT with the available equipment.

Results.—The results obtained with emulsifiers added to No. 2 fuel oil con-

[1] The work described in this paper was done under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development to the Bureau of Entomology and Plant Quarantine.

taining 5 per cent of DDT are given in Table 1. At 0.05 and 0.025 pound of DDT per acre good control was obtained, and at the other dosages there was little difference in the control obtained with the various emulsifiers. However, in two tests with formulas containing Triton B-1956, at 0.05 pound of DDT per acre, the control was less than 90 per cent. These sprays were applied without the boom, and an unsuccessful attempt was made to drift the sprays.

All the emulsifiers made equally good emulsions with the exception of Triton B-1956, which was unsatisfactory when it was used with water having a high sulfur content. There were no appreciable differences in the effectiveness of the emulsions with the various emulsifiers used. Excellent results with GI soap and other wetting agents have also been reported.[2]

Slightly better results were obtained when a greater quantity of spray was used with the very low dosages of DDT. Usually the mortality was lowest where the vegetation was the heaviest, the thick vegetation tending to screen out most of the spray.

[2] Personal communication from Capt. W. C. McDuffie, Sn. C., U. S. Army.

TABLE 1. Effect on *Anopheles* larvae of quick-breaking emulsions made from 5 per cent of DDT in No. 2 fuel oil.

Emulsifier and concentration	Dosage per acre		Area of Plot	Larvae obtained before treatment (20 dips)	Reduction due to treatment
	Total Spray	DDT			
	Quarts	*Pounds*	*Square Feet*	*Number*	*Per Cent*
Triton B–1956 (polyglyceride of a glyptal resin) 2%	5	0.05	6800	579	99.0
	5	.05	2000	170	88.9
	10	.05	2200	404	97.1
	25	.05	3500	304	85.6
	5	.025	2000	154	94.2
	5	.025	1500	271	99.2
	12.5	.025	1500	271	99.6
	5	.0125	1500	174	95.4
	12.5	.0125	1500	194	96.9
Triton X–100 (an aralkyl polyether alcohol 2%	5	.025	1500	225	98.6
	12.5	.025	1000	209	99.6
	5	.0125	1500	236	83.9
	12.5	.0125	1500	187	97.4
Triton X–100 0.5% + Triton B–1956 1.5%	5	.025	1500	281	98.2
	12.5	.025	1000	185	100.0
	5	.0125	1500	195	82.6
	12 5	.0125	1500	230	97.4
Triton X–100 0.5% + Emulphor ELA (polyglycol ether ester) 1.5%	5	.025	1000	310	96.5
	12.5	.025	1000	120	98.7
	5	.0125	1500	160	87.4
	12.5	.0125	1500	221	91.4
Span 20 (sorbitan monooleate) 1% + Tween 20 (polyoxyalkylene derivative of sorbitan monolaurate) 1%	5	.025	1000	293	99.4
	12.5	.025	1000	202	100.0
	5	.0125	1500	255	90.2
	12.5	.0125	1500	196	91.4
No emulsifier	.5	.05	1000	99	97.0
No. 2 fuel oil	1	None	225	48	31.25

TABLE 2. Effect of treatment with fuel-oil solutions of various emulsion concentrates containing 25 per cent of DDT on *Anopheles* larvae breeding in small chara-filled pools. Dosage 0.1 pound of DDT per acre.

Emulsifier and concentration	Solvent (68%)	Area of pond	Larvae per dip before treatment	Reduction
		Square Feet	*Number*	*Per Cent*
Triton X–100 7%	PD–544–C (all aromatic petroleum fraction	400	7.35	86.4
	Hi-flash solvent (a coal-tar fraction)	135	7.9	96.2
	Xylene	240	10.4	62.5
Span 20 5% + Tween 20 5%	do.[1]	406	13.2	99.3
Span 20 3.5% + Tween 20 3.5%	do.	350	8.7	92.0

[1] Only 65 per cent of solvent used.

Table 2 gives the results of unreplicated tests made in chara-filled pools treated with various concentrations diluted with No. 2 fuel oil. The emulsifiers used in these tests were also good spreading agents for the oil carrier. The concentrate containing 25 per cent of DDT, 7 per cent of Triton X-100, and 68 per cent of xylene gave the least satisfactory results.

In the practical test the quick-breaking emulsion gave better control of *Culex quinquefasciatus* than did the oil spray. The wind drifted the material the width of the lake, and good control was obtained even though most of the spray fell within 150 feet of the point of application. Although the larval population was not immediately checked (the late fourth instars being more resistant and continuing to pupate), the residue from the treatment prevented larval development for 2 weeks. Breeding was heavy on the pond as indicated by the observed egg rafts.

Summary.—The use of 2 per cent of an emulsifier in a solution containing 5 per cent of DDT in No. 2 fuel oil permits the addition of water from the breeding places of mosquitoes, and this makes it possible to obtain the quantity of spray necessary for thorough distribution of the low dosages of DDT with the available equipment. Any emulsifier may be used which will form good emulsions with fuel oil. The emulsion concentrates may be used to form quick-breaking emulsions by diluting 1 part of concentrate in 4 parts of fuel oil.

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TESTS ON THE AIRPLANE APPLICATION OF DDT FOR THE CONTROL OF ADULT MOSQUITOES IN OPEN, UNWOODED AREAS

C. B. WISECUP,[1] WILLIAM C. BROTHERS,[2] AND PAUL M. EIDE [1]

Studies by members of the Orlando, Fla., laboratory of the Bureau of Entomology and Plant Quarantine during 1943 demonstrated that satisfactory control of adult salt-marsh mosquitoes (*Aedes taeniorhynchus* [Wied.] and *A. sollicitans* [Walk.]) could be obtained by airplane applications of sprays containing DDT (1-trichloro-2, 2-bis [*p*-chlorophenyl] ethane) over dense mangrove jungles (Lindquist *et al.* 1). Later tests in conjunction with the United States Army showed that marked reductions in the populations of adult *Anopheles albimanus* Wied. and *Mansonia* spp. were possible in the tropical forests of Panama (Lindquist *et al.* 2). The tests herein reported were conducted in 1944 in the open, unwooded areas of east-central Arkansas against adults of *Anopheles quadrimaculatus* Say and *Psorophora* spp.

The large area of cultivated rice surrounding the Army Air Field near Stuttgart, Ark., was found to be highly favorable for the production of large populations of both *Anopheles* and *Psorophora* mosquitoes. Two series of tests were conducted in this area against the adult mosquitoes that were present during the period July 1 to September 4, 1944.

Methods.—The first series of tests was concerned with the control of adult mosquitoes within the breeding areas of the numerous rice fields in conjunction with tests of DDT as a mosquito larvicide (Wisecup *et al.* 3). Observations were made in 14 fields on the effectiveness of such treatments in reducing the annoyance from *Psorophora* adults. Owing to the habit of *Anopheles quadrimaculatus* of leaving the rice fields, it had been found inadvisable to use nail-keg catching stations in such environments for determining populations of this species, but such stations were useful near locations where blood meals for mosquitoes were available, such as water holes and shady places where livestock gathered. It was found that enormous numbers of *Psorophora* spp. continued to remain in the rice fields, so that rather satisfactory estimations of the number present before and after treatment could be made from landing-rate counts.

The second series of tests was made in areas representative of forward, bivouac, and cantonment areas, consisting of pastures, abandoned fields, and the cantonment area of the Stuttgart Army Air Field. The results of spraying such areas were evaluated by sampling the mosquito populations with the aid of light traps, nail-keg catching stations, and landing counts.

Three lots of material obtained from different sources were used, at dosages ranging from 0.1 to 1.0 pound of DDT per acre. Applications were made with 5 or 10 per cent strengths of emulsions or oil solutions. The emulsions were water dilutions of a basic concentrate consisting of 25 per cent of DDT, 7 per cent of *Triton X-100* (an aralkyl polyether alcohol), and 68 per cent of xylene. The oil sprays consisted of DDT dissolved in No. 2 fuel oil (Diesel oil) with cyclohexanone added as an auxiliary solvent for the 10 per cent solution.

Most of the applications of DDT were made from liaison-type airplanes, with the

[1] Entomologists, U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine, working under a transfer of funds, recommended by the Committee on Medical Research, from the Office of Scientific Research and Development.

[2] First lieutenant, Sanitary Corps, U. S. Army Air Forces. Equipment and untrained personnel were supplied by the Stuttgart Army Air Field, Eastern Flying Training Command, U. S. Army Air Forces; by the Corps of Engineers of the Eighth Service Command; by the Office of the Chief of Engineers; and by the Office of the Surgeon General, U. S. Army.

removable spray unit designed at the Orlando laboratory for such airplanes. Swaths of 40-foot width were flown across the wind, starting on the leeward side of the area. In addition, a single large area was treated from a Stearman biplane, 80-foot swaths being made.

Results. *Tests in Rice Fields.*—The results of the tests made in the rice-field breeding areas are summarized in Table 1.

TABLE 1. Results of airplane treatments of rice fields with DDT emulsions for control of *Psorophora adults.*

Date of Application	Dosage of DDT per Acre	Area Treated	Control
1944	*Pound*	*Acres*	*Per Cent*
	Lot 1 of DDT		
July 5	0.2	43	96
6	.2	36	91
	.1	25	89
11	.2	55	98
	Lot 3 of DDT		
11	.2	65	80
	.2	60	20
15	.2	3	80 (90) [1]
22	.2	16	93 (96)
	Lot 2 of DDT		
	.4	36	90
27	.4	20	94
28	.8 [2]	15	100
Aug. 4	.4	30	100
11	.4	23	95
	.8 [2]	30	100

[1] Figures in parenthesis refer to control in check plots treated with another lot of DDT.
[2] A 10-per cent DDT emulsion was used.

In all cases where marked reductions were noted in the number of mosquitoes following a treatment, it was also possible to find large numbers of dead adults floating in the water among the rice plants.

It was evident that the airplane application of 0.1 pound or more of DDT from lots 1 and 3 was effective in reducing the abundance of mosquitoes from annoying hordes to an occasional pest. The inferior results obtained with lot 2 were due to the application of minimum dosages of a material which was below standard both physically and chemically.

Area-Control Tests.—To gain information on the effect of DDT sprays on adult *Anopheles quadrimaculatus,* as well as on *Psorophora* spp., six tests were conducted whereby large, open, nonbreeding areas were treated.

A summary of these tests is presented in Table 2. This table shows the average counts of *Anopheles quadrimaculatus* per nail-keg catching station for about a week before the applications, both in the treated area and in a comparable untreated area; the average number of *Psorophora* spp. captured in portable light traps during the same period; and in certain tests the average landing rate per minute and the average number of *Psorophora* spp. captured in New Jersey light traps.

The application on July 11 was made to a square-mile area consisting of rice fields, pastures, farm lots, overgrown weedy rice fields of the preceding year, and an abandoned railroad right-of-way. Both the *Anopheles* and *Psorophora* populations were building up rapidly at this time, so that increases were shown in both the treated and untreated areas. The differences in the populations between these areas were insignificant, and it was apparent that the treatment had no bearing on the adult populations as registered by the methods of collecting which were employed.

The treatment on July 29 was applied to 300 acres of pasture, cultivated fields, and railroad right-of-way. The *Anopheles* population was still increasing at this time, as shown by the increases in both treated and untreated locations, but the *Psorophora* population had commenced a decline which later resulted in an almost complete absence of this usually abundant pest. There was an indication that the application had been somewhat effective against the anophelines, as the increase of this group in the treated area was only half that in the check area. The differences in catches of *Psorophora* between treated and untreated areas were again insignificant.

On August 7 an oil solution and a water emulsion of DDT were compared

TABLE 2. Summary of mospuito abundance in area-control tests, together with decrease or increase following treatment with DDT, as shown by nail-keg catches for *Anopheles quadrimaculatus* and light-trap catches for *Psorophora* spp. in open, nonbreeding areas.

Date	Dosage of DDT per Acre	Area Treated	Species	Plot	Mosquito Population Before Treatment	Decrease (—) Increase (+) Following Treatment
1944	*Pound*	*Acres*			*Number*	*Per Cent*
			5 Per Cent Emulsion			
July 11	0.24	640	*A. quadrimaculatus*	Treated	3.6	—64
				Untreated	25.2	—66
			Psorophora spp.	Treated	1,816	+28
				Untreated	1,594	+38
29	.24	300	*A. quadrimaculatus*	Treated	13.6	+34
				Untreated	13.2	+69
			Psorophora spp.	Treated	3,598	—19
				Untreated	2,104	—26
Aug. 7	.24	28	*A. quadrimaculatus*	Treated	5	—32
				Untreated	11.4	—95
			Psorophora spp.	Treated	4,624	—59
				Untreated	5,306	—50
				Treated	13.5 [1]	—89 [1]
				Untreated	16.2 [1]	—34 [1]
			5 Per Cent Fuel-Oil Solution			
Aug. 7	.24	28	*A. quadrimaculatus*	Treated	5.8	+32
				Untreated	38.1	—25
			Psorophora spp.	Treated	5,497	—80
				Untreated	3,564	—86
				Treated	17.9 [1]	—93 [1]
				Untreated	16.2 [1]	—34 [1]
25	.5	195	*A. quadrimaculatus*	Treated	12.2	—34
				Perimeter	21.3	+63
				Untreated	117.5	+44
			Psorophora spp.	Treated	1,032	—67
				Untreated	198	—46
			10 Per Cent Fuel-oil Solution			
Sept. 3	1.0	550	*A. quadrimaculatus*	Treated	104	—50
				Untreated	88	—15
			Psorophora spp.	Treated	163	—75
				Untreated	258	—91
				Treated	34.4 [2]	—42 [2]
				Untreated	73.0 [2]	—52 [2]

[1] Landing rates.
[2] New Jersey light traps.

in tests on a 56-acre pasture having a small stream, half the area receiving each treatment. Very contradictory results were obtained in these comparisons, possibly owing to the small areas employed. Decided decreases in the numbers of *Anopheles* were noted in both the treated and untreated portions of the plot to which the emulsion had been applied, but there was an increase in the oil-treated plot. The populations of *Psorophora* continued to show decreases during the period of checking, with nearly equal numbers in all areas, both treated and untreated, shown in the light-trap collections. Marked differences in numbers of *Psorophora* between the treated and untreated plots were shown by the landing-rate counts, the treated areas being almost entirely free of biting adults in early morning and at dusk.

As the mosquito populations had con-

tinued large in the area treated on July 29, a second treatment was applied to the central 195 acres of this area on August 25, this time with DDT in fuel oil. The decided decrease in the number of *Anopheles* in the single nail keg placed in the center of the area, with increases in the stations around the perimeter and in the untreated areas, indicated that this treatment had been effective. There was a more marked decrease in the number of *Psorophora* within the plot than was noted outside.

The final test was made on the cantonment area of the Stuttgart Army Air Field with 10 per cent of DDT in fuel oil applied on September 3. A Stearman (PT-17) biplane equipped with a removable spray apparatus with venturi mounted under the fuselage was used on two-fifths of the area, and the same plane equipped with an apparatus to produce a finely dispersed spray from an engine exhaust generator was used on another two-fifths. A liaison-type plane (L-2) equipped with a removable spray apparatus with venturi mounted under the fuselage was used on the remaining one-fifth of the area. The different types of spray equipment were calibrated so that each applied approximately 1 pound of DDT per acre. As shown in Table 2, there was an over-all reduction of *Anopheles* amounting to 50 per cent, in contrast to a natural decrease of only 15 per cent outside the treated area. *Psorophora* populations had by this time decreased to the point where light-trap records were unreliable indices of their abundance.

Discussion.—In the course of these tests on the effects of spraying large, open nonbreeding areas with DDT for the control of adult mosquitoes, it became evident that basic information was lacking on several factors that enter into such control. Too little was known concerning either the daytime or the nighttime habits of *Anopheles* and *Psorophora* adults. If the adult mosquitoes escape initial contact with the poison, there then remains the possibility of a later control by means of residues deposited on the foliage. Because of the marked residual action shown by DDT under experimental conditions, a high degree of control under natural conditions can be hoped for, provided sufficient residue has been deposited in locations which the mosquitoes would subsequently contact long enough to obtain a lethal dose.

The main source of data on populations of pest mosquitoes of the genus *Psorophora* was catches in in single light traps operated for several nights before and after treatment. These data demonstrated the tremendous variations in populations which were encountered during the season. By the last of August the numbers had decreased to only a fraction of those found during the peak of infestation. Less than a 25 per cent difference in the populations of adult mosquitoes as measured by light traps, however, was shown between the untreated and treated areas in all tests. It therefore seems probable that the use of light traps is an unsatisfactory method of determining *Psorophora* populations in areas of 1 square mile or less, owing to the habit of these mosquitoes of flying great distances and their known attraction to lights.

Despite the unsatisfactory evidence presented by light-trap collection, the few data obtained on landing rates and the very satisfactory results noted in tests against *Psorophora* adults in the rice fields warrant special emphasis. The landing-rate counts in the area treated on August 7 are indicative of the relief from these pests which was noted in many other instances. In both the treated areas daytime mosquito annoyance was negligible in comparison with that before treatment. Although there was a slight natural decrease in the untreated area, the difference between the treated and untreated portions of this pasture was evident for several days after treatment. The data obtained from these area-control tests indicate that early-morning and late-evening relief had been secured from the annoyance of pest mosquitoes, even though no actual decrease in nighttime numbers, as measured by light-trap collections, was shown. It appears that sufficient residue had been

deposited to control the nightly influx of mosquitoes from the surrounding area.

The data in Table 2 show very strikingly the tremendous changes in populations which took place within both treated and untreated plots during very short periods of time. It is probable that natural forces exerted greater influence on the results than did the treatments.

The general conclusion drawn from the data in Table 2 was that no appreciable control of *Anopheles quadrimaculatus* had been obtained from applications of DDT sprays at dosages from 0.2 to 1.0 pound of active ingredient per acre. There were indications, however, that the increase of these adults following the treatment on July 29 was much less in the treated area than in the untreated area. In the cantonment area it appeared that the decrease in the treated area was much greater than the natural decrease outside. Since increases were found in the stations around the perimeter and outside of the treated area, it is possible that the marked decrease at the station in the center of the 195-acre plot treated on August 25 was due to the treatment. The reductions were considered not to constitute control.

Summary.—Large-scale tests of the effectiveness of DDT in controlling adult *Anopheles* and *Psorophora* mosquitoes were conducted during the period May 25 to September 4, 1944, in the rice fields and pasture lands near Stuttgart, Ark.

Fourteen tests, involving over 450 acres of growing rice, made with liaison-type airplanes indicated that the abundance of *Psorophora* adults was reduced by at least 90 per cent when rice fields were sprayed with 0.1 pound or more of high-grade commercial DDT per acre in an aqueous emulsion. There were definite indications that 0.1 pound was a minimum dosage, and that inferior results were secured from the use of substandard materials.

Six area-control tests, involving several hundred acres of pasture and waste lands in large, open nonbreeding areas, indicated that:

(1) Techniques for determining adult mosquito populations should be improved.

(2) Treatments with either fuel oil or aqueous emulsion containing DDT at dosages of 0.2 to 1.0 pound per acre were of doubtful effectiveness against adults of *Anopheles quadrimaculatus* Say as measured by nail-keg catching stations.

(3) Light-trap collections of adult *Psorophora* spp. showed no marked differences between treated and untreated areas.

(4) Landing-rate counts of *Psorophora* spp. showed marked reduction of daytime annoyance from these mosquitoes in the treated areas.

(5) Apparently there is an extensive nighttime activity of adult mosquitoes of both *Psorophora* spp. and *Anopheles quadrimaculatus* under conditions of open, unwooded terrain, with a heavy breeding pressure from surrounding rice fields. Under such conditions light traps and catching stations are not suitable methods of evaluating differences in populations unless very large areas are to be treated.

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EFFECTIVENESS OF DDT AS A RESIDUAL TREATMENT OF BED NETS

B. V. TRAVIS [1, 2]
U. S. Naval Medical Research Unit No. 2

Observations in the South Pacific showed that *Anopheles farauti* Laveran was frequently found hiding in bed nets. So important was this resting place that all troops were warned to take special precautions to eliminate mosquitoes from their nets before retiring. This location was also a favorite resting place in native villages. Obviously, mosquitoes so closely associated with man would be of considerable importance in the transmission of malaria. Data by Gahan *et al.* (1945) demonstrated that DDT sprays applied to the walls of buildings would kill mosquitoes that attempted to rest on the treated surfaces. Tests of a similar nature were made to determine the efficacy of a DDT residue spray on bed nets to kill mosquitoes that attempted to rest in them.

Materials and Methods: A series of regulation bed nets were sprayed with equipment available to malaria control units in the South Pacific. The spray material was 5 per cent DDT in kerosene. One set of nets was sprayed with the cylindrical pressure sprayers (decontamination) equipped with whirl plate nozzles and one set with paint spray guns adjusted to deliver large droplets. The procedure of spraying was to spread the nets and pile them one on top of the other. The top net was sprayed on one side after which it was reversed to start a new pile and then sprayed on the opposite side. The rate of application was 1.0 pint per net with the paint sprayer and 1.5 pints per net with the cylindrical pressure sprayer. The nets were hung in the sun to dry and were then folded and stored for 37 days.

In making the tests, one net that had been treated with each type of sprayer was installed in normal fashion over a bed. Adult, laboratory-reared *Anopheles farauti* were released under the nets. Two types of tests were made. In one, the mosquitoes were left in the nets until all were knocked down, while in the other the exposure period was varied. After being exposed in the nets, the mosquitoes were transferred to clean cages and observed for mortality rate. With the varied exposure times, the observer remained under the net with the mosquitoes. Three exposure times were obtained by transferring groups of the mosquitoes to clean cages 2, 5, and 10 minutes, respectively, after they were placed under the nets. Control insects were released in an untreated net and later transferred to clean cages.

Results: The preliminary tests in which mosquitoes were confined in the nets until all were knocked down showed no difference in effectiveness of the nets treated with the different types of spray apparatus. Nearly all mosquitoes were knocked down in 45 minutes. Only one mosquito out of 94 survived an hour and it was dead by the end of the second hour. None of these mosquitoes recovered and there were no deaths among the controls.

Additional tests with the varying exposures showed, Table 1, that all mosquitoes were dead 24 hours after 2, 5, and 10 minutes exposures to treated bed nets. In fact, 86 to 100 per cent were knocked down within four hours after such exposures. None was dead in the controls.

Discussion: It was noted that the mosquitoes were exceptionally active under the nets and were continually probing with the proboscis as they tried to escape through the meshes. The habit of probing openings as they sought escape holes

[1] Lieutenant, H(S), USNR, on military leave from U. S. D. A., Bur. Ent. & Pl. Quar.

[2] The writer is indebted to Capt. P. Oman, SnC. AUS; Lt. J. D. Maple, H(S), USNR; and Mr. C. N. Husman, Naval Civilian Technician for the spraying of the nets.

TABLE 1. Percentage of *Anopheles farauti* Laveran knocked down at intervals following exposure of 2, 5, and 10 minutes in bed nets sprayed with DDT-kerosene solutions; Guadalcanal, 1944.

Interval after exposure	Exposure in minutes: Decontamination sprayer 2	Decontamination sprayer 5	Decontamination sprayer 5	Decontamination sprayer 10	Paint sprayer 2	Paint sprayer 5	Paint sprayer 5	Paint sprayer 10	Check	Check
	Number of insects: 22	21	34	34	22	35	20	38	25	27
	Per cent knockdown									
15 min.	6	9	14	15	8	4	6	10	0	0
30 min.	15	9	38	38	26	23	11	20	0	0
1 hour	44	23	52	47	42	41	18	40	0	0
2 hours	71	41	62	76	66	64	40	65	0	0
3 hours	91	64	86	97	87	77	91	85	0	0
4 hours	100	95	100	100	92	86	91	95	0	0
24 hours	100	100	100	100	100	100	100	100	0	0

allowed more DDT to get on them than if they had rested quietly. The mosquitoes began to show definite discomfort and began vigorously to wipe the proboscis within two minutes after being released under the nets. Their legs showed jerking movements and by the end of five minutes typical symptoms of DDT poisoning were evident.

Anopheles farauti appeared to be more inclined to try to crawl through small openings than did *A. quadrimaculatus*. This habit was noted when small individuals were observed to crawl through 16-mesh wire screen. They escaped easily at the corners of the cages and in places where they could wedge their bodies into the wire openings.

Mosquitoes that were liberated under the treated nets with the observer attempted to bite rather freely for a period of about two minutes, but after five minutes none attempted to bite. As soon as the mosquitoes showed definite signs of DDT poisoning they ceased to bite.

These tests show that a residue-DDT treatment of bed nets will effectively knock down mosquitoes that attempt to rest under the nets. The rapid mortality of mosquitoes exposed for only two minutes indicates that large numbers may even be killed as they crawl about on the outside of the nets in attempts to reach the man underneath. Results of such treatments of bed nets indicated that this is a satisfactory way of killing mosquitoes that rest in them. It provided a method that is adaptable to mass treatments and that does not depend on the action of an individual for his own protection. Treatments of bed nets of natives should be helpful also in reducing the number of infected mosquitoes.

Summary: Tests show that DDT residues on bed nets, treated at the rate of 6 to 8 nets per gallon of a 5 per cent DDT in kerosene, will kill mosquitoes that attempt to rest in the nets. Biting of *Anopheles farauti* stopped as soon as they exhibited symptoms of DDT poisoning, which was two to five minutes after exposure to treated nets.

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BIGGER AND BETTER SPRAYING UNITS

LOYDE E. YETTAW
The Des Plaines Valley Mosquito Abatement District, 8130 Ogden Avenue, Lyons, Illinois

Do you dare to break the shackles of tradition by pioneering or developing a new and radical idea in the method of doing your job? Back in 1935, we, the Des Plaines Valley Mosquito Abatement District, took that precarious step, and not once have we regretted it.

Truck building companies ridiculed the idea of mounting 13.50 x 24-inch tires on a standard truck. Their idea of "pay load" and "tire bursting pressure" had almost become an obsession with them. Through the cooperation of the Goodyear Tire Company and a very progressive group of men that compose our board, we converted a Chevrolet truck into a marsh buggy and mounted a six-gallon-per-minute Bean Sprayer on it. It worked so well that we have since acquired three more, respectively, 14, 20, and 35-gallon-per-minute jobs, all mounted on all-wheel drive trucks with large tires. Two are mounted on 13.50 x 24 tires, the other two on 13.50 x 32 farm tractor tires. Our experience has been with small and large pumps mounted on both conventional and cab-over-engine trucks, used in mosquito breeding areas that were at one time controlled entirely by hand sprayers.

Breeding areas differ in size, shape, and density of vegetation. Mid-summer or late summer spraying is in dense vegetation and a person needs plenty of force to drive the larvicide through the vegetation to the water surface. If done by hand the operator can spray a swath not more than four feet on each side of him, or a total of eight feet wide. A power sprayer of six-gallon capacity per minute, under the same conditions, will cover 16 feet; a 14-gallon-per-minute will cover 40 feet; a 20-gallon-per-pinute will cover 60 feet; and a 35-gallon-per-minute will cover 80 feet. Any one of these sprayers can be choked down to as low as three gallons per minute if necessary, by simply changing the size of the tip of the nozzle.

Pumps from six gallons to 20 gallons per minute take up the same space and have about the same weight. Larger ones require heavier construction and heavier motor, so the division is at the 20-gallon size.

Experience teaches that labor cost is the largest item in spraying. A man spraying does not recognize how many gallons per acre he is using, but he does recognize a standard film that will kill mosquito larvae. It is logical that the more gallons per minute he can spray and yet hold to that standard film the cheaper the cost per acre; therefore, it is cheaper to use the larger sprayer because of the increased distance the spray will reach. He can cover an area of 40 feet from the truck without taking out hose or even getting off the truck. By taking advantage of the wind drift, it is possible to reach as much as 200 feet.

Another very important item is the fact that mixed oil, one part oil and 10 parts water, thoroughly agitated, and sprayed under 500 to 800 pounds pressure injures no vegetation. The force of this driving spray will penetrate the most dense vegetation, leaving a thin toxic film on the water surface. This film should take about 15 gallons of oil per acre on non-polluted areas. Polluted areas require from 15 to 25 gallons per acre, depending on the amount of surface scum which retards the spread of the oil.

Power sprayers are going to play a big part in the use of DDT. We handled it very successfully against flies, especially on city dumps and in horse barns. Should an epidemic of polio break out, we are well equipped to fog a whole town with this new miracle insecticide.

The use of power sprayers is not new;

neither is the use of all-wheel drive trucks. Mosquito control organizations have been slow to recognize the advantage of combining the two, and mounting the truck with 13.50 x 24 or 13.50 x 32-inch farm tractor tires. Without trying to diagnose the reason for this hesitancy, I will try and paint a word picture of our 20-gallon unit.

Fig. 1. The skeeter-eater demonstrating heavy going in a polluted marsh area.

Take an all-wheel drive truck chassis, cab-over-engine type, 101-inch wheel base. Leave the windshield on, but remove the cab. Replace the conventional tires and wheels with 13.50 x 24-inch, or 13.50 x 32-inch farm tractor tires and wheels to match. You now have a foundation on which to build. With about 20-gage sheet metal, build a wide cab (no top) about 38 inches high, this will come about a foot below the top of the windshield. Two bucket seats make up the furniture. With one-inch pipe and step plate steel build a railing and platform entirely around the truck, from the rear of the cab to the back end of the truck frame. The platform should be flush with the frame and about 8 inches wide, except about three feet of the back end. Here the entire width of the frame is covered to form a platform. The railing should be about 36 inches high, the same height as the cab, and have a 14-inch hook on each upper rear corner on which to hang hose. We use about 200 feet (Hose Test—1800-pound working pressure).

The cab will take up about 5 feet of the frame and the rear platform 3 feet. In the six-foot space between the two we pack our spraying unit which consists of a 200-gallon tank, 20-gallon-per-minute pump, and gasoline motor which drives the pump and agitator: This tank is 36 inches high and mounted forward. It is divided into three sections, a tool box, a 60-gallon supply compartment, and a 100-gallon mixing compartment. The mixing compartment houses an agitator which keeps the larvicide thoroughly

mixed. A pipe line leads from the mixing tank to the supply tank; two pipe lines lead to the spray hose, one out of the sump on the bottom of the tank, and one about an inch above the bottom of the tank. Spraying is done from the latter, so that the pump will not lose its prime before the tank is empty. Refilling is done from the sump connection. The injector type refiller, mounted on the side of the mixing tank is connected to the sump and empties into the top of the tank through a screen. For refilling, 15 feet of 2½-inch suction hose is connected to the refiller. This has a screened end to prevent sucking up foreign material which would clog or ruin the pump.

The 60-gallon supply tank is enough to cover four acres of marsh or six refills in the mixing tank. Seven minutes is the approximate time it takes to refill. This spray unit is operated by three men, and has sprayed as much as 25 acres in one day (8 hours).

The 20-gallon high pressure pump is connected with pipes to the supply tank, mixing tank (top and bottom), refiller, and spray hose line, and is mounted just behind the 200-gallon compartment tank. The bottom of the pump is flush with the truck frame. A simple valve system enables each line to the pump to work independently of the other.

The little Hercules gasoline motor which powers the pump and agitator is suspended above the pump by a framework of angle iron, and anchored firmly to the truck frame. It faces to the rear of the truck, the crank extending into the rear platform to avoid an awkward cranking position.

This unit will negotiate a three-foot ditch if the ditch has one to one and one-half slopes. It will travel in 3½ feet of water without "shorting out" the motor. It has about 22 inches clearance underneath, so will wallow through plenty of mud or clear quite high obstacles such as stumps, logs, or bent-over saplings. This is a very efficient off-the-highway unit.

The unit is sturdy and will take dual tires on both front and rear wheels. Each 13.50 x 24 tire operating in 3 inches of mud has 9 inches by 24 inches, or 216 square inches of contact with the ground. In a foot of mud this increases to about 13.50 x 36, or 486 square inches.

Larger units than 20-gallon-per-minute require a longer wheel base and are less maneuverable, but are much the better unit for large ditches or marshes where it is necessary to take out the hose.

COMPOSITION OF DDT PRODUCTS

J. M. GINSBURG
New Jersey Agricultural Experiment Station, New Brunswick

In view of the recent release of DDT for experimentation and civilian use, mosquito control workers throughout the world became interested in it as a potential mosquitocide. However, considerable confusion prevails concerning the different brands, isomers, solutions, emulsions and dust mixtures supplied by commercial concerns. Another mooted question is the precautions necessary in handling the various DDT preparations without undue health hazard. It is with the purpose of elucidating on this subject for the benefit of the MOSQUITO NEWS readers that this article was written.

The symbol DDT is an abbreviation of the term dichloro-diphenyl-trichloroethane, $(C_6H_4Cl)_2CHCCl_3$. Since many isomers (compounds which have the same molecular formulas but differ from each other in their physical and chemical properties) of this chemical may be prepared, some

of which possess low toxicity to insects, the name DDT is confined to the compound obtained from the reaction of chloral with chlorobenzene in the presence of sulfuric acid as follows:

$$CCl_3CHO + {}^2C_6H_5Cl = (C_6H_4Cl)_2CHCCl_3 + H_2O$$

Chloral — Chlorobenzene — DDT — Water

The product obtained by this process consists essentially of two isomers namely,

I Para-Para (P,P′) DDT = 70 — 80%
II Ortho-Para (O,P′) DDT = 15 — 20%

and a small amount of impurities. Of these two isomers the P,P′–DDT was found more toxic to mosquitoes and other insects than the O,P′–DDT.

Types of Commercial DDT Products

DDT is now supplied commercially in several forms: powders, dust mixtures, solutions, and concentrated emulsions.

DDT-Powders

At present three grades of DDT powders are specified: technical, purified or aerosol, and pure DDT. The *technical grade* is the commercial product above described. Since its melting point, due to the presence of impurities, is not sharply defined it is required to possess a minimum "setting point" value of 88° C. The *aerosol grade* is partiallly refined, containing approximately 97 per cent or more P,P′–DDT and should have a minimum melting point of 103° C. It has been, up till now, used in preparing aerosol bombs for the U. S. armed forces and for experimental work. The *pure grade* is highly refined, consisting entirely of the P,P′–DDT isomer, with a constant melting point of 108.5–109° C., designated chemically as 1-trichloro-2,2-bis (P-chlorophenyl) ethane. It is intended for use as a standard comparison for special chemical and toxicological studies.

DDT-Solutions

The *technical* DDT is naturally the lowest in cost and is the grade generally employed for insecticidal purposes. It is of light cream color, insoluble in water but readily soluble in a wide variety of organic solvents such as benzene, xylene, cyclohexanone, ethylene dichloride, fuel oils, and many others. In some solvents as much as 50 per cent DDT by weight can be dissolved, whereas other solvents will hold only from 5 to 10 per cent DDT in solution. For mosquito and fly spraying enough of the technical grade can be readily dissolved in kerosene or fuel oil by shaking or mixing.

Solutions containing from 5 to 35 per cent DDT are supplied commercially which may be used instead of the powder in preparing various desired concentrations in oil. Also concentrated emulsions, containing various amounts of DDT, which can be mixed with water to any desired concentration, may be now purchased.

DDT-Dusts

Several brands of *wettable* and *non-wettable* dust mixtures are also available. The *wettable dusts* consist of 20–50 per cent DDT, a small amount of wetting agent and the balance inert carrier such as talc or pyrophyllite. This type of dust disperses in water to form suspension sprays of any desired concentration. The *non-wettable dusts* are not dispersible in water and are prepared for dusting purposes only. They generally contain from 3 to 10 per cent DDT and the remainder inert carriers.

Solutions and dust mixtures, based on actual DDT content, are considerably higher in price than the technical grade of DDT powder, due to the added cost of solvents, carriers, wetting agents, mixing operation and extra freight charges. The writer has observed no difficulties in using DDT powder for making up oil solutions and emulsions, either in the laboratory or in the field for mosquito spraying.

Precautions in Using DDT

Besides being highly toxic to insects, DDT is also poisonous to man and higher animals and may, if not properly employed, constitute a health hazard. In

lethal dosages it attacks the nervous system and causes pathological conditions in the liver and other internal organs. In pure or technical powders and in dry dust mixtures DDT is not toxic on contact unless ingested in comparatively large quantities or handled with greasy, oily hands. However, in solutions of oil or other solvents, DDT becomes poisonous on contact and inhalation. In oil solutions it is readily absorbed through the skin and intestines. The following precautions are generally recommended for workers who intend to use DDT to a considerable extent either for experimental or practical application.

When mixing or spraying solutions or emulsions of DDT, wear *neoprene gloves, goggles* and a *respirator*. Wear a *wide-brimmed hat* to prevent spray from depositing on head and face. *Do not* allow DDT solution to remain on *skin* or to *saturate clothing*. When accidentally spilt on clothes, change them promptly. If concentrated DDT solution gets on the skin, *wash immediately* with soap and water. Do not spray baby beds, children's toys, food, dishes and rooms occupied by sick persons. Cover or remove all food and cooking utensils from room before dusting or spraying. Do not store DDT near food supplies.

MAKE YOUR PICTURES COUNT

JAMES T. HART, JR.
Morris County (N.J.) Mosquito Extermination Commission

Almost every operating agency performing mosquito or malaria control work takes pictures of its work in some form or another. The majority of these pictures, I venture to say, are taken as snapshots for record purposes only, and after a short time are thrown into the desk drawer where they accumulate from time to time.

On occasions a good photograph is necessary for a newspaper article or an exhibit and an outstanding picture to suit that purpose usually is hard to find. Usually the pictures, at the time they are taken, seem interesting but actually most of them lack good human interest by being crowded with a great deal of unimportant material. These pictures were taken without forethought and were never expected to be used on exhibits. It only takes a few minutes, in the off season, to plan the anticipated photographs needed for your year's educational needs, and with few exceptions these could be taken in the early part of the season or when conditions prevail. Your photographer can play a leading role in making your pictures of better quality. He can enlarge your original negative and leave out the uninteresting parts, thus improving your picture a great deal. Your photographer should be asked to take special care in developing all of your film. Developing your film in fine-grain developer may cost a bit more than the ordinary development but it pays its dividends when enlargements are desired for educational and exhibit purposes. In many cases the ordinary run-of-the-mill development will not always do the work you may desire of your negatives.

In our organization we have found that most of the good photographs we had have disappeared; they have either been given away, loaned or are in use on permanent exhibits. We have catalogued all of our photographs and are now starting to print all our negatives so we have a complete file of photographs. We have planned a program for 1946 to secure a number of good photographs for this coming year to fill our exhibit needs. We intend to have the photographs on hand this year for the exhibits we are anticipating rather than worry about what we're going to use shortly before the exhibit is to be displayed.

THE OCCURRENCE OF *ANOPHELES QUADRIMACULATUS*, *ANOPHELES OCCIDENTALIS* AND *ANOPHELES WALKERI* IN VERMONT

RALPH C. BARNES

Malaria Control in War Areas, U. S. Public Health Service

Anopheles quadrimaculatus Say is known to be widely distributed throughout Eastern United States. It has been previously reported in all of the eastern states except Vermont (Johnson, 1925; King and Bradley, 1941). Collections which we have made during the 1945 season indicate that *A. quadrimaculatus* occurs in the State of Vermont and is rather common in the Lake Champlain Valley. The writer has identified males, females and larvae of this species from five localities ranging from East Dorset in the southern part of the state north to Burlington.

Anopheles occidentalis Dyar and Knab has been known to occur in southern Canada and northern United States as well as in the Pacific Coast region. In the East it has been reported in Connecticut, Maine, Massachusetts, New Hampshire and New York (King and Bradley, 1941). We now have a record of this species from Danby (Rutland County), Vermont where a single female was collected from an animal shed on August 31, 1945 by C. A. Wilson. One male and nine females of *A. punctipennis* Say were collected from this same shelter.

Anopheles walkeri Theobald has a rather wide distribution in Eastern United States and is known from all of the New England States except New Hampshire and Vermont (King and Bradley, 1941; Knutson, 1943). Two larvae of this species have now been identified from Hubbardton, Vermont, where they were collected in association with *A. quadrimaculatus* larvae on August 26, 1945.

Collection data for *A. quadrimaculatus* and *A. walkeri* are summarized as follows:

Burlington (Chittenden County), August 25, 1945. One male * and 13 females of *A. quadrimaculatus* were collected from a small turkey shelter located a short distance west of State Route No. 127 and about four miles north of Burlington. One female *A. punctipennis* was also collected from this shelter.

East Dorset (Bennington County), August 31, 1945. Three males * and four females of *A. quadrimaculatus* were collected from under a bridge by C. A. Wilson. From this same bridge one male and one female of *A. punctipennis* were also taken.

Hyde Manor (Rutland County) August 26, 1945. Approximately 500 anopheline larvae were collected in 40 dips from the shallow marginal waters of Lake Hortonia. The collections were made along State Route No. 30 about two miles south of Hyde Manor. From this collection, 21 fourth instar larvae were identified and all were found to be *A. quadrimaculatus*. Thirty-three additional larvae were reared and identifications were made from the adults thus secured. All of these specimens were also *A. quadrimaculatus* (17 males and 16 females).

Hubbardton (Rutland County) August 26, 1945. A collection of larvae was made from the shallow waters of Lake Bomoseen along State Route No. 30 just south of Hubbardton. In 30 dips, 150 anopheline larvae were taken. Fourth instar larvae which were identified were *A.*

* Identification verified by genitalia.

quadrimaculatus (9) and *A. walkeri* (2). Seven other larvae which were reared were found to be *A. quadrimaculatus* (3 males and 4 females).

Brandon (Rutland County) August 29, 1945. A larval collection was made by C. A. Wilson from a pond along U. S. Route No. 7 about four miles south of Brandon. Five fourth instar larvae which were identified from this collection were *A. quadrimaculatus* (2) and *A. punctipennis* (3). Twenty additional specimens which were reared were found to be *A. quadrimaculatus* (1 male) and *A. punctipennis* (9 males and 10 females).

The specimens of *A. occidentalis, A. walkeri* and a sample of those of *A. quadrimaculatus* referred to above have been deposited in the U. S. National Museum, Washington, D. C. The remainder of the specimens are preserved in the collection of the District No. 1 office of Malaria Control in War Areas, U. S. Public Health Service, New York, New York.

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ASSOCIATION NEWS

THE AMERICAN MOSQUITO CONTROL ASSOCIATION FIELD TRIP TO THE WASHINGTON, D. C., AREA

HELEN LOUISE TREMBLEY
National Institute of Health, U. S. Public Health Service, Bethesda, Md.

The American Mosquito Control Association met at Washington, D. C., November 20 and 21, 1945, for an inspection trip in that area.

Mr. Perry W. Ruth, President of the Association, and members assembled at 1 P.M. November 20, in the offices of Doctor F. C. Bishopp, Chairman of the Arrangements Committee. At this time, each member was furnished a mimeographed itinerary of the field trip, a prospectus of projects, and an identification tag, and was then assigned to a car for the tour.

Shortly thereafter, the party, in ten automobiles, proceeded through Rock Creek Park and across the city to the Rockville Pike in Maryland, where the first stop was made at 2:15 at the Naval Medical Center in Bethesda. Here the party formed two groups, each in turn, visiting the Naval Medical School and the Naval Medical Research Institute.

Captain Clyde L. Bozarth, M.C., U.S.N., Executive Officer of the Naval Medical School, welcomed the group aboard, and Lieutenant Commander William J. Perry, H(S), U.S.N.R., gave the members an illustrated talk on health problems and malaria control activities as met by the armed forces in the Pacific war areas. At the conclusion, an exhibit was held, demonstrating material covered in medical entomology classes and malariology in the Naval Medical School, and a few of the available insecticides used overseas were demonstrated.

Meanwhile, the members visiting the Research Institute, were greeted by Captain E. G. Haakansson, M.C., U.S.N., Medical Officer in Command. Lieutenant (j.g.) L. A. Jachowski, H(S), U.S.N.R., in charge of entomology, conducted the visitors through the insectary and testing rooms, and explained that the colonies of *Anopheles quadrimaculatus* and *Aedes aegypti* were being maintained for malaria transmission, and *Musca domestica* and *Blatella germanica* for insecticide investigations. He said also that studies at the Institute have included long-term investigations on mosquito repellents, which yielded (1) a standardized testing procedure, and (2) a number of excellent mosquito repellents.

At about 4 P.M. the party left for the National Institute of Health, U. S. Public Health Service, located just across the road from the Naval Medical Center. Here they visited the Malaria Drug Testing Laboratory, Doctor G. Robert Coatney, in Charge. This laboratory since 1941 has participated in a co-ordinated search for better anti-malarial drugs. Large-scale screening tests in chicks are conducted in Bethesda, and promising drugs are used elsewhere in trials on experimentally infected humans. Doctor Coatney and Doctor W. Clark Cooper, Senior Assistant Surgeon, discussed the project informally, and explained charts showing typical infections and drug responses in both chick and human malarias. Routine preparation and administration of drugs to chicks were demonstrated by the laboratory staff. In the insectary, *Aedes aegypti* mosquitoes are raised primarily for the transmission of *Plasmodium gallinaceum,* a bird malaria, and colonies of *Aedes atropalpus* and *Anopheles quadrimaculatus* are maintained for transmission and other experimental projects. Helen Louise Trembley discussed rearing procedures briefly, and explained methods of mosquito, or sporozoite, infection and transmission.

The group left by auto at approximately

5:30 P.M. for dinner at Hayden Farms, Silver Spring, Maryland, stopping en route for an hour of cocktails and informal discussion. At Hayden Farms, the party was augmented by a number of men from local control groups, and dinner at 8 o'clock furnished excellent food which added to the enthusiasm and good-fellowship already prevailing. After dinner, President Perry W. Ruth welcomed members and guests of the American Mosquito Control Association, and graciously expressed his appreciation of the efforts of the Committee on Arrangements: Doctor F. C. Bishopp, Chairman; Mr. H. H. Stage, Major H. L. Felton, and Miss H. L. Trembley.

Four phases of mosquito control work were included in the evening's program; speakers and topics follow:

Col. Paul F. Russell, Chief of Division of Parasitology, Army Medical Center. "Malaria and Its Control in Liberated Italy in 1944."

Dr. Newell E. Good, U. S. Public Health Service. "Mosquito Surveys and Inspections in the D. C. Area."

Lt. J. M. Hutzel, Insect Pest Control Section, Bureau of Medicine and Surgery, U. S. Navy. "Entomological Activities in the Marine Division."

Mr. H. H. Stage, Asst. Chief, Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. "Control of Anopheles Mosquitoes by Residual Sprays."

A very short period of comment and discussion on the papers was followed by adjournment of the evening's session at 11 P.M.

Wednesday morning, November 21, at 8:30, the automobile party left the Willard Hotel in downtown Washington for the Agricultural Research Center at Beltsville, Maryland.

The air was cold, but there was little wind, so the first stop was made at the airfield. Here a White Standard Plane with spinner disc attachment was viewed. The pilot explained the mechanism of airplane application of insecticides, and demonstrated by a trip testing procedures, including methods of studying swath-width, particle size, particle distribution, and effects of atmospheric conditions.

Laboratory inspections were scheduled to begin at 10 A.M., and the party divided into three groups, the first visiting the Division of Insecticide Investigations under Doctors R. C. Roark and H. L. Haller. Chemical investigations on DDT were demonstrated and explained briefly by the staff: chemical and physical properties of DDT, by S. J. Cristol; DDT formulations, by E. E. Fleck; analytical investigations of DDT insecticides and of DDT deposits on vegetation, R. H. Carter; and analytical investigations of DDT in minute amounts by the colorimetric method, M. S. Schecter. The chemistry of pyrethrum was discussed by Dr. F. B. LaForge in his laboratory, where a method for the preparation of purified pyrethrins has been developed, so that odorless non-irritating pyrethrum sprays can be made. The purified pyrethrins are also well-suited for use in aerosols. Liquefied gas aerosols were explained and some demonstrated by Dr. L. D. Goodhue. The object of his work is the development of improved aerosol formulas and equipment for the control of insect pests.

Meanwhile, the second group of Association members was visiting the Division of Control Investigations, Dr. C. P. Clausen, in Charge. Biological evaluation of insecticides and fabric resistance to mosquitoes is carried on under the direction of Dr. E. R. McGovran, who briefly discussed the project. New materials, improved formulations of known insecticides, new methods of applying insecticides, etc., are tested on insects, and the more promising discoveries are forwarded to other Divisions for thorough tests under practical conditions. Demonstrations and short talks were given as follows:

Mosquito rearing—Mrs. A. H. Casanges
Housefly rearing—Mrs. S. J. Beahm
Turntable spray tests—W. A. Gersdorff

Peet-Grady Chamber tests—J. H. Fales
Residual tests and roach tests—P. G. Piquett

The testing of fabrics for resistance to mosquito bites, under the supervision of Mrs. M. F. Schott, was of much interest. The object of these tests is to determine which fabrics used in the uniforms of the armed forces of the United States will provide the most protection against mosquito bites.

A third group of members, during this time, was inspecting the laboratories of Mr. Randall Latta, where thermal aerosol investigations are underway. Smoke aerosols are produced by heating a solution of the insecticide in oil in a generator adapted from machines used for military screening smokes. Drifting aerosol "clouds" in many cases give a high percentage of kill over a considerable area. A wind tunnel is used to study insecticidal efficiency so that exact comparisons can be made relative to particle size, rate of air movement, and formulation of the insecticide.

Rotation of the three visiting groups was arranged so that everyone had inspected all of the laboratories by 1 P.M., the time scheduled for lunch at the Log Cabin, which is the Research Center's cafeteria. At the conclusion of this meal, a few words were spoken by several members including a short farewell by President Ruth. Adjournment followed.

Excellent weather and a general spirit of friendliness and co-operation contributed much to the success of the meetings, and "Tommy" Mulhern's patience and industry with his camera has furnished a photographic record as evidence of the work and pleasure experienced by all.

PROTECTING MARINES FROM INSECT-BORNE DISEASES *

J. M. HUTZEL
Insect Control Division, Bureau of Medicine and Surgery, U. S. Navy

The rapid expansion of our armed forces early placed a drain on the Navy's reserves of trained malariologists. To meet the demand for personnel in this field, physicians, entomologists, parasitologists, sanitation engineers and others qualified in one or more phases of preventive medicine were commissioned and sent to special schools located in Naval hospitals, such as the National Naval Medical Center, and in various "Boot" camps. Here they were given intensive review in the diagnosis and control of malaria and other insect-borne diseases. When the courses had been completed the men were organized into malaria control units and assigned to shore-based Naval activities and Marine divisions.

Malaria control units attached to Marine divisions were faced not only with the problems encountered by garrison and training forces, but also with those arising from protection of large numbers of men under combat conditions. Prior to an assault operation it was necessary for the malaria control unit to become well versed in the available medical intelligence about the objective. Troops were then indoctrinated through lectures, moving pictures, posters and other means of disseminating information as to the sanitary conditions they were likely to encounter and special precautionary measures peculiar to the invasion. Emphasis was laid on the control of insects and protection from their bites,

* Author's resumé of a paper read before a meeting of the Association at Washington, D. C., Nov. 20, 1945.

the use of suppressive drugs where indicated, and avoidance of populated areas serving as focal points for the spread of epidemic diseases.

In addition to the indoctrination program malaria control units saw to it that all troops were properly equipped to combat insect-borne diseases, and that the quartermaster maintained an excess supply of this equipment to meet possible emergencies arising, for example, from an overlong campaign.

During the assault and initial occupational stages the malaria control unit landed and directed insect control activities as early as the tactical situation would permit. Before DDT became available in large quantities it was impossible to provide insect control concurrent with assault action and the distribution of insecticides was largely dependent upon hand operated devices. The properties of DDT, however, made possible its effective distribution via plane so that large areas could be rapidly and effectively treated for the control of mosquitoes and flies. Because airplane application offered a means of protecting advance troops from insects during the time when other control measures were inoperative, the method was investigated with enthusiasm by nearly all branches of the armed forces.

DDT was first sprayed from Navy planes under combat conditions during the attack on Peleliu, the planes operating from captured airstrips before the island had been secured. Prior to that time plans had been projected to use carrier-based aircraft to protect assault troops from insect-borne diseases. However, technical difficulties were not overcome until late in 1944 and it was not until about two months before the operation that plans were approved for spraying Iwo Jima with DDT during the attack.

The spraying of Iwo Jima was made a joint responsibility of Army, Navy and Marine forces in order to provide for uninterrupted insect control from the assault through occupational stages. The malaria control unit of the 4th Marine Division, participating in the initial assault, was charged with the responsibility of co-ordinating all insect control activities on the island during the invasion. Members of this unit went ashore on D plus 5, where they found that mosquitoes were no problem, but that flies were abundant and threatened to become a menace. The concentration of artillery fire prohibited the employment of low-flying carrier planes for spraying purposes until D plus 9. At that time the situation was well enough in hand to permit two Navy torpedo bombers equipped with spray apparatus to lay swaths of insecticide in a criss-cross pattern over the occupied portion of the island. As a result the housefly population dipped to almost zero by the following day. Thereafter, a daily survey indicated those areas most in need of treatment. These were plotted on target maps and the appropriate carrier airgroup notified by radio to spray a given target area. When the carriers had withdrawn, Army air transports equipped for spraying DDT were flown up from Saipan and directed by the malaria control unit until relieved by the Garrison Surgeon. In the subsequent operation, the attack on Okinawa, the tactical situation permitted spraying on D plus 1 and 22 square miles of beachhead were covered by carrier-based aircraft before land-based planes assumed this responsibility.

Plane spraying had the disadvantages of other space spraying devices so that military personnel in occupied areas continued to rely heavily upon the early introduction of semi-permanent and permanent control measures and the use of hand operated apparatus for the distribution of insecticides. When it is considered that the major benefits of DDT were realized only shortly before the end of the war, the fact that malaria control units accomplished so much with so little is indeed a tribute not only to their resourcefulness, but to all agencies, civilian and military, whose research contributions implemented broader and more effective disease control programs.

THE USE OF DDT RESIDUAL SPRAYS IN NATIVE MEXICAN HOMES FOR CONTROLLING *ANOPHELES PSEUDOPUNCTIPENNIS* MOSQUITOES *

H. H. STAGE
Bureau of Entomology and Plant Quarantine

After three years of accelerated research we believe the greatest promise for DDT in malaria mosquito control is in its use as a residual spray. This information was first developed by the Orlando, Florida, entomologists early in 1943 when wooden boxes and canvas cages were treated with 5 per cent DDT sprays at the rate of from 10 to 400 milligrams per square foot. Into these boxes and cages adult mosquitoes were released and within a few hours they were killed simply by resting on the treated surfaces. The amazing thing was that high mortalities of mosquitoes continued weeks and months after treatment when new batches of mosquitoes were placed in the treated cages.

Backed with this information James B. Gahan, B. V. Travis, F. A. Morton, and A. W. Lindquist successfully reduced the numbers of anopheline mosquitoes in buildings, first in the vicinity of Tallahassee, Florida, and later in Stuttgart, Arkansas, during August 1943. In Arkansas the tests were run in co-operation with John E. Taylor and L. H. Biggs of the U. S. Public Health Service and employees of the Arkansas State Board of Health.

A more important large-scale test was next conducted in 1944 in a large rice-growing section near Stuttgart where nearly every building in two 9-square-mile areas were sprayed with 5 per cent DDT sprays. This test was to determine the effectiveness of such treatment against *Anopheles quadrimaculatus* mosquitoes. The spraying was completed in June. Up until October, the end of the season, the treatment remained effective and reduced the adult mosquito population by over 90 per cent and the larval population of *A. quadrimaculatus* in the rice fields over 55 per cent.

During the summer of 1945, in co-operation with Dr. George C. Payne of the Rockefeller Foundation, Mr. Gahan conducted still other tests with DDT as a residual spray. This time his efforts were directed against *Anopheles pseudopunctipennis,* a potent carrier of malaria, breeding in rice fields in the State of Morelos, Mexico. In this instance Mr. Gahan directed his 5 per cent DDT residual spray onto the interior of all the native houses in two villages, each of which contained about 400 homes. These houses were made of adobe, cornstalks, or rice straw walls with thatched, tile, or straw roofs. The homes were sprayed in April and May. When I visited Mr. Gahan in early October 1945, some five months after his first treatments were applied, I was amazed to see how few mosquitoes we could find in the houses and rice fields in the treated villages compared to the number seen in untreated villages.

Acute and chronic malaria is common in the Mexican towns treated by Gahan. From what little information we could obtain it appears that a reduction of malaria was effected. However, at least three years of residual spray treatment will no doubt be necessary before positive evidence of the value of this method in reducing malaria will be known.

Working with another important malaria vector and in houses built of a variety of materials Gahan has again demonstrated the practicability of reducing anopheline populations with DDT residual sprays.

Kodachromes illustrated the types of places treated and techniques used.

* Author's resumé of an address before a meeting of the Association at Washington, D. C., Nov. 20, 1945.

NEWS AND NOTES

ARTHUR H. GEIB has been appointed Superintendent of the Dr. Morris Mosquito Abatement District at Bakersfield, California, succeeding Fred L. Hayes, who died on October 16, 1945.
H. F. GRAY

THE SUTTER-YUBA MOSQUITO ABATEMENT DISTRICT was formally organized on January 18, 1946. This district comprises the larger part of Sutter County, and the valley portion of Yuba County, in the central part of the Sacramento Valley. Headquarters probably will be at Marysville, California. The area is largely under irrigation for diversified farming. H. F. GRAY

G. EDWIN WASHBURN of the U. S. Public Health Service (MCWA) has been appointed Superintendent of the new Turlock Mosquito Abatement District, and will begin work about March 15, 1946. Headquarters will be at Turlock, California. The area of this district is about 360 square miles in the southern part of Stanislaus County east of the San Joaquin River.
H. F. GRAY

LT. RICHARD PETERS, after a tour of duty with the Sanitary Corps of the Army, most of it spent on mosquito control work in the South Pacific, has returned to the Bureau of Sanitary Engineering, State Department of Public Health, and is again taking over the supervision of mosquito control measures in California.
H. F. GRAY

ANNUAL MEETING OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION. The program for the annual meeting of the California Mosquito Control Association, to be held at the University of California February 25–26, 1946, has been completed. A fine attendance from the Pacific Coast states is expected. H. F. GRAY

PROPOSED NEW MOSQUITO CONTROL LEGISLATION. Several bills relating to mosquito control have been introduced into the special session of the California State Legislature and so far have received very favorable consideration. One appropriates $600,000 to the State Department of Public Health, of which $400,000 must be matched by local districts in the malaria and encephalitis endemic areas, for more intensive mosquito control work in these areas.
H. F. GRAY

MAJOR T. H. D. AITKEN, after distinguished service in the Army Sanitary Corps in Central America and Europe (where he directed malaria control operations on Corsica), returned to Berkeley on terminal leave for a short visit. He joins the staff at the Rockefeller Foundation, and will go to Italy with Dr. F. L. Soper and Dr. D. Bruce Wilson for malaria control work in Sardinia. H. F. GRAY

MR. C. EDWARD ANDERSON of Morris Plains, N. J., and a member of the Association, was released by the Army in December. Mr. Anderson served as a sergeant in the 94th Malaria Control Detachment in New Guinea and the Philippines. JAMES T. HART

LT. COL. JOHN T. MORRISON, M.C., has returned from the E. T. O. where he was Surgeon of the 1st Civil Affairs Regiment and Commanding Officer of the 1st Medical Detachment in Public Health Operations operating in France, Belgium, Holland and Luxembourg. He also served as Public Health Officer of the Greater Hessen district of the U. S. Occupational Zone. Dr. Morrison is a member of the Morris County Mosquito Extermination Commission and is associated with the Commonwealth Fund, New York City. JAMES T. HART

ROBERT L. VANNOTE, past president of the Association, has withdrawn from the position of Superintendent of the Morris County Mosquito Extermination Commission and in addition to supervising the inter-county program in the Passaic Valley will operate the firm of Robert L. Vannote, Inc., specialists in insect control.
JAMES T. HART

CAPTAIN JAMES T. HART, JR., has returned to the Morris County Mosquito Extermination Commission after serving in the Pacific area with the 105th Malaria Control Detachment. On March 1 he assumes the position of Superintendent of the Morris County Commission.
R. L. VANNOTE

ZOOLOGICAL BARRIERS FOR MALARIA CONTROL IN THE U.S.S.R. Shortly before the war the Central Institute for the Study of Malaria and a number of anti-malaria institutions under its control completed an experiment which had lasted many years, in the "zoo-prophylaxis" of malaria. By means of special cowsheds and stables on stock-breeding farms, a zoological barrier was formed between settlements and mosquito breeding places. According to a report by P. Sergeyev in the American Review of Soviet Medicine (Vol. 3, No. 2, December, 1945; p. 124), all or almost all of the mosquitoes flying from the swamps were attracted to the animals and did not reach human habitations. There was a correlated decrease in the number of mosquitoes discovered with human blood in their stomachs. The first year this zoological "line of defense" was erected the number of malaria cases dropped to 25 per cent of that of the preceding year, whereas in another area used as a control, with no animal barriers, no decline occurred. In another instance this method was considered successful in reducing the incidence of malaria in settlements on the banks of a new reservoir. D. L. COLLINS

NEW ANOPHELINES REPORTED FROM SOUTH PACIFIC. Collections of insects by trained entomologists in the armed forces during the second world war have resulted in the finding of many new species as well as in the accumulation of significant new distributional and biological data. Thus, a new species of *Anopheles* (*A. nataliae*) has recently been described from Guadalcanal by Captain John N. Belkin (Belkin, J. N.: *Anopheles nataliae*, a New Species from Guadalcanal. Journ. Parasitol. 31, No. 5, pp. 315–318, Oct. 1945).

Belkin and others had previously reviewed the Anophelines of the Solomon Islands and New Hebrides (Belkin, J. N., Knight, K. L., and Rozeboom, L. E.: Journ. Parasitol. 31, No. 4, pp. 241–265, Aug. 1945) and concluded that there were at least 6 species in those areas, an addition of at least 4 species to the previously recognized list. In addition, these writers have assembled valuable biological and ecological information on the several species, including new species such as *A. koliensis* Owen, the original description of which is found in the same journal, pp. 236–240, in a paper by Captain W. B. Owen. Studies of *A. koliensis* led to the conclusion that it is of primary importance in disease transmission.

D. L. COLLINS

ANOPHELES PUNCTIMACULA, DYAR & KNAB, was incriminated as a vector of malaria in a letter to the editor by Carl B. Huffaker, as quoted in the NEWS for March 1945 (Vol. V, No. 1, p. 19). In that letter it was stated that a more detailed account would "appear probably in the Amer. Journ. Trop. Med. in the near future." It is appropriate, therefore, to note here that a paper entitled "*Anopheles Punctimacula*, D. & K., as the Vector of Malaria in Medellín, Colombia, South America," by Hernando Rey, Hernando Soto and Carl B. Huffaker appeared in the November 1945 issue of the American Journal of Tropical Medicine (Vol. 25, No. 6, pp.501–505).

This paper presents the evidence for the "conviction," based on malarial surveys of school children, and of persons in their homes; and on biological and histological studies of the four species of *Anopheles* found in the region around Medellín. *Anopheles punctimacula* was the only species which frequented human habitations, and also the only one found to be naturally infected. Of special interest to students of mosquito biology as well as to those planning control measures, is the fact that this species, usually described as breeding in "well shaded waters" or in "shaded ground pools," was found in breeding places far removed from wooded land, in urban water holes fully exposed to the sun. It is pointed out that these exposed breeding places were at a moderately high altitude (about 5,000 feet). This fact poses the question as to whether or not its limitation to well shaded places in hot areas may not be due to a simple difference in temperature. The authors consider that this question deserves experimental study. D. L. COLLINS

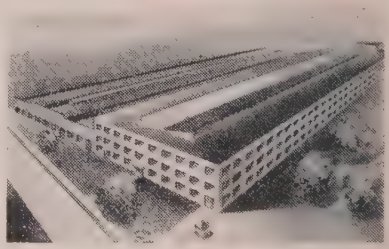
MR. RAY H. SAMMIS, Superintendent of the Nassau County, New York, Mosquito Extermination Commission, is now sojourning in St. Petersburg, Fla., for an extended vacation. Meanwhile Duncan E. Longworth, who has recently returned after completing several years' service with the Army as a Major, engaged in malaria control work, is Acting Superintendent for the Nassau County Commission, 75 Lee Avenue, Rockville Centre, N. Y. T. D. MULHERN

ANABASINE SULFATE AS A MOSQUITO REPELLENT. The American Review of Soviet Medicine, in the same article cited with reference to zoological barriers in malaria control, mentions (p. 123) that although none of the many substances tried as mosquito repellents were completely successful, during 1942 and 1943 anabasine sulfate, an alkaloid derived from the central Asiatic desert plant *Anabasis aphylla* was found promising. Although the solution of the sulfate smeared on the skin did not keep the mosquitoes away entirely, the number of bites on smeared surfaces was considerably less than on unsmeared surfaces. Antimalaria organizations have begun making practical use of anabasine sulfate as a mosquito repellent. A more complete account of the preliminary experiments is given in a paper by V. A. Nalokov, entitled "Anabasine Sulfate: A Protective Agent Against Bites of Malarial Mosquitoes" in the same journal, Vol. II, No. 5, June 1945, pp. 449–452. Here it is stated that a 5 per cent aqueous solution prevented biting by means of its action on the taste organs of the mosquitoes.

D. L. COLLINS

DR. THOMAS J. HEADLEE, formerly Entomologist with the New Jersey Agricultural Experiment Station and one of the founders of this Association, is spending the winter at his cottage at 210 Malverne Road, West Palm Beach, Fla.

T. D. MULHERN



JOHN BEAN MANUFACTURING COMPANY HAS NEW HOME. "Another of the Nation's 'swords' is being 'beaten into a plowshare' with the purchase of a Lansing, Michigan, war plant by John Bean Mfg. Co., pioneer manufacturer of orchard and row-crop sprayers and other types of agricultural machinery. One year ago, the new home of the John Bean Mfg. Co. was part of the largest airplane propeller factory in the world."

From a press release.

EDITORIAL SECTION

AN OPEN LETTER TO THE MEMBERSHIP

When I received from Dr. Glasgow a request for a contribution to the March issue of Mosquito News, I realized that this was a welcome opportunity to speak to the membership at large on a subject that has impressed me very forcefully. I refer to the extremely important part the News is now playing and must continue to play in the growth and life of our American Association.

One has only to compare the last December issue of Mosquito News with that of four years ago to realize that this magazine, fathered by pioneers with vision, has now grown up to occupy a place in very favorable contrast with any similar publication. And all this has not come about by accident but through the tireless effort of those men who have had the foresight and the tenacity of purpose to keep going in the face of the many obstacles of the last few years and who have sacrificed much that the Association might live on and prosper.

There can be little doubt but that anti-mosquito work is a field that will greatly grow in the future. Publicity during this World War centered much attention on the mosquito and the danger to health which it constituted both here and abroad and the fact that mosquito breeding could be controlled became an established fact. We Americans are not inclined to put up with discomfort that can be avoided and the annoyance of pest mosquitoes is no less easy to bear that that caused by disease carriers.

I believe that scores and hundreds of cities and communities which had never heard of mosquito control a few years ago will be introduced to it by their returning service men who have seen it in action and many of whom will have been trained in its fundamentals. I believe that new units, large and small, will come into being all over our country as well as in countries abroad and it will be in connection with these new units that our Association can perhaps render its most valuable service. The problems to be met by these units may vary greatly according to their geographic location or other contributing causes, even though they are working toward a common goal, and if our organization has the foresight to earnestly seek their affiliation, the mutual benefit will be great. The interchange of thoughts and ideas and the dissemination of new discoveries are the foundation stones on which a solid structure may be built through co-operation, while the expansion of our membership may in turn increase our ability to serve. Truly, our official publication is an ideal means to this end.

Through this medium the policy of the organization as well as the developments of science can be carried to the far places, while news of the far places may be of the greatest interest near at home. In this connection I wish to urge every member who may read these lines to take just a little time from his other work and write briefly to our Editor. Any item of personal news about yourself or some other member; what problems you have or anticipate; or a short description of the sort of work you are doing. They may seem very commonplace to you but you would be surprised how interesting such notes could be to others. Your contribution does not have to be a scientific treatise or a polished editorial to be worthwhile. So do not hesitate to give the Editor the help he needs and welcomes.

Perry W. Ruth,
President.

REVIEWS AND ABSTRACTS

PRIMATE MALARIA. S. D. Aberle, M.D. (with 13 collaborators). National Research Council, Division of Medical Sciences. Issued by the Office of Medical Information (Under grant of the Johnson & Johnson Research Foundation), 171 pp. March 1945. This report is limited to malaria in monkeys and apes and is designed to give research workers a view of contributions in the subject and to provide a source of ready reference. The bibliography at the end is complete through October 1, 1944, and contains 457 references. The author points out that there is no accepted nomenclature for all primates. In Table II there is a list with approved genus and species of all monkeys listed in the bibliography of primate malaria. Table I gives the commonly-used names of the *Plasmodia*, their natural hosts and the hosts into which these plasmodia have been successfully inoculated. Table IV lists the vectors which have been used and the results of transmission experiments. The author points out the interesting fact that some of the human and primate parasites are able to exist in the blood of species other than the native host without causing pronounced symptoms.

Nineteen pages of the report are devoted to Table VIII which sets forth the results of experimental work on the chemotherapy of primate malaria. Pages 83 to 112 are concerned primarily with immunity and the pathology of simian malaria caused by *Plasmodium knowlesi*. There are twelve excellent plates showing cycles and stages of development and pathological effects of various species of *Plasmodia*.

W. B. HERMS

OPERATIONS MANUAL FOR FIELD USE OF DDT. Medical Department, Standard Oil Company (New Jersey), 30 Rockefeller Plaza, New York, N. Y.

The small booklet (62 pages) discusses DDT primarily from the standpoint of control of insects of medical importance. It is divided into six parts, as follows:

I. Chemical properties
II. Biological properties
III. Types of preparations
IV. Types of uses
V. Control of insect pests
VI. Precautions in application

The booklet, which is a compilation of studies made by various agencies, contains much information on DDT and almost every type of preparation and use for this insecticide are discussed. It will prove valuable to those concerned with the control of insects affecting man and animals, although too much emphasis is given to certain methods of employing this insecticide which are not generally recommended. The same general information is discussed in several topics and because of the fact that the vast amount of available information on this insecticide is greatly condensed, the manual strikes the reader as being repetitious. Some of the more recent information on formulations and most effective methods of use apparently were not available when the manual was compiled, consequently it is not entirely up to date.

E. F. KNIPLING

ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT. ANNUAL REPORT FOR 1945. Court House, Oakland 7, Calif., February 1946. 22 pp. (Mimeographed.)—Of particular interest both to mosquito control engineers and to research workers are the results of experiments with DDT mentioned in this report. The following resumé of work described in the report will give an idea of the extent and results of work with DDT in Alameda County: In June 1945, with a small supply of DDT, some of it in emulsifiable form, several types of application were tried, principally to try its effectiveness in underground utility vaults, street catch basins, culverts, bridges, etc. Places which had been prolific breeders in past years were sprayed with a 2½ per cent emulsion to produce a residual deposit of DDT on the side walls and ceilings, or the under sides of bridges and culverts. The results were excellent. The residual effect of the DDT in most cases eliminated breeding for the remainder of the year and was considered to justify the use of DDT as a residual spray on an extensive scale in 1946. Directions for such use have been prepared and distributed to the division foremen. Also, a series of sheets has been prepared giving tables and quantities of DDT in various solutions and emulsions for surfaces, and for both still and flowing water, in order to simplify calculation and to minimize errors.

A 2½ per cent solution of DDT in Diesel oil was thought to be the most economical medium for residual application. If oil stain had to be avoided, the standard xylene-emulsifier mixture, with water, is recommended.

Worthy of note as a statement on a subject which at present appears to be controversial, is the following sentence: "Our experience with DDT as a larvacide indicates that it is difficult with equipment at present available to us to apply economical quantities of DDT in area spraying, and there does not appear to be appreciable advantage in adding DDT to spray oils for application to water surfaces, though we will continue observations along this line in 1946."

The report contains many figures and tables relative to the fiscal affairs of the District, which are of interest from a comparative viewpoint to mosquito control officials in other parts of the country.

D. L. COLLINS

LOS ANOFELINOS DE LA REPUBLICA DEL ECUADOR. Roberto Levi Castillo. 170 pp., 49 illus., 15 plates of anopheline taxonomic characters, and 5 maps giving the geographical distribution of the 11 anophelines known in Ecuador. Published by Artes Graficas Senefelder C. A. Ltda., Guayaquil, Ecuador.

This volume gives the geographical distribution, relative importance, and something of the ecology in Ecuador of *Anopheles bathanus* Dyar, *A. pseudopunctipennis levicastilloi* Levi-Castillo, *A. p. rivadeneira* Levi-Castillo, *A. eiseni* Coq., *A. punctimacula* Dyar and Knab, *A. apicimacula* Dyar and Knab, *A. mediopunctatus* Theo., *A. albimanus* Wied., *A. aquasalis* Curry, *A. neivai* How., Dyar and Knab, and *A. boliviensis* Theo.

The author believes *Anopheles bathanus,* first discovered in Guayaquil in Ecuador by Komp, will be found sooner or later in the five coastal provinces of Ecuador and that no doubt other species of this genus will be discovered in Ecuadorian territory. Larvae were taken in small pools of still water on the road from Guayas province to Manabi province. The author thinks that this anopheline occurs no further south than Ecuador.

According to Dr. Levi-Castillo there exist two autochthonous races of the *Anopheles pseudopunctipennis* complex in Ecuador—*A. p. rivadeneirai,* the main vector of malaria in the warm highland valleys of Ecuador, and *A. p. levicastilloi,* which has never been found naturally infected, and does not occur above an average altitude of 300 meters above sea level. *A. p. rivadeneirai,* however, reaches a maximum of 2,500 meters above sea level, the highest point, according to the author, ever achieved by any anopheline in the Western Hemisphere.

Anopheles eiseni is a wild and seldom seen species. It breeds in shaded streams and on the rocks in pools of water containing abundant *Spirogira.* It is found in most of the Andean and all of the coastal provinces of Ecuador at altitudes of 86 to 2,100 meters above sea level.

Anopheles punctimacula occurs in the five coastal provinces, Esmeraldas, Manabi, Los Rios, Guayas, and El Oro. It is mostly zoophilous and breeds in shady pools in the jungle.

Anopheles apicimacula is also zoophilous and can only be found deep in the jungle of all the coastal provinces. From a taxonomic standpoint, it is similar to *A. punctimacula* except that in the latter species the scales are predominantly black and yellowish whereas in *A. apicimacula* they are mostly white.

Anopheles mediopunctatus, the ecology of which is little known, is a very rare anopheline in the interior of the coastal provinces.

Anopheles albimanus is considered the main vector of malaria of coastal Ecuador and is the species most generally distributed in that region.

Anopheles aquasalis is the only anopheline breeding in brackish waters in Ecuador, and, according to the author, it may be *A. albimanus* that has adapted itself to such a habitat.

Anopheles neivai is found in the five coastal provinces and breeds only in Bromeliads from sea level to 1,000 meters in elevation.

Anopheles boliviensis was captured in Mera in the Amazon region of Ecuador. This species is a suspected vector of malaria.

Taxonomic characters of adults, larvae, and eggs are given. H. H. STAGE

DDT WATER EMULSION IN RICE FIELDS AS A METHOD OF CONTROLLING LARVAE OF ANOPHELES QUADRIMACULATUS AND OTHER MOSQUITOES. Frederick L. Knowles and Frank W. Fisk. United States Public Health Service Reports. Vol. 60, No. 35, pp. 1005–1019. Aug. 31, 1945.—The extensive areas used for rice cultivation, the susceptibility of growing rice to injury, and the necessity of continually flooding, providing an ideal habitat for Anopheles larvae as well as added insecticidal difficulties, present a total problem of no mean proportions to the malariologist. The authors have attempted to find a practical solution to this perplexing problem in the use of DDT. Their experiments were made in the Stuttgart area of Arkansas where water pumped from deep wells or reservoirs is used for flooding the rice fields. A 100-acre field of rice plus 30 plots of 1/20 acre in size were made available for experimental purposes. The DDT water-miscible larvicide was prepared as follows: DDT (degree of purity not given)—*1 part;* solvent—*3 parts* (xylene or Culicide Oil B, Socony Vacuum Oil Co. or dendrol, Standard Oil of Indiana); Triton X-100 (emulsifier made by Rohm & Haas)—*1 part.* The stock solution was diluted with water to the desired concentration. The larvicide was dispensed at a predetermined rate in the flooding water at the pump by means of an applicator pump (ordinarily used for chlorination). Larval sampling stations were set up. DDT was applied individually to each of the 30 small plots. In general the larval counts in the larger field increased with the distance from the pump, indicating a gradual loss in the toxicity of the DDT-treated water as it flowed through the canals and rice fields. The factor of distance from point of application was of course, eliminated in the 30 small individually treated plats. In comparison with an untreated rice field, two plots of the larger treated field contained 50 per cent fewer *A. quadrimaculatus* larvae and 72 per cent fewer culicine larvae. In the smaller (1/20 acre) plots complete control of anopheline and culicine larvae was obtained at concentrations of 1.0 p.p.m. and 0.2 p.p.m. DDT respectively. The authors point out that although the application of DDT to the flooding water as it enters the rice fields results in a reduction, it by no means eliminated production of larvae. Yields of harvested rice in the DDT-treated 100-acre field were higher than the average or highest yields for previous years from untreated fields. The authors report that numerous *Gambusia* were seen in the untreated fields and none in the treated fields.

W. B. HERMS

SALT MARSH AND ANOPHELINE MOSQUITO FIELD CONTROL TESTS WITH THE HOCHBERG-LAMER INSECTICIDAL GENERATOR USING OIL-DDT AEROSOLS. Victor K. LaMer, Frank Brescia, Irwin B. Wilson, Kenneth C. Hodges, and John C. Rowell. National Defense Research Committee, Office of Scientific Research and Development Report No. 5731. September 18, 1945. Processed 70 pp. The control of adult mosquitos by toxic aerosols involves the dissemination of a toxic agent into the air, in the form of minute particles, and allowing the wind to carry the particles over the area in which the insects are located. The toxic agent used in the tests reported herein is an oil solution of DDT.

The diameter of the particles is very important. If they are too small, as in the "screening smoke" size range (0.6–1.0 mu), only a very small portion contact the insects, whether the insect is at rest or flying around. The greater part is carried around the insects with the air in which they are suspended. If the particles are too large, as in the "spray" size range (40 mu or greater), they fall to the ground a short distance from the point of dispersal. It must be realized that to control large areas, the dispersed particles must remain airborne for large distances downwind and must remain within the space wherein the insects are resting or flying.

The most efficient particle size diameter for adult kill is about 10 microns. Such particles possess sufficient inertia to give appreciable vertical and horizontal deposition and have little tendency to follow the streamlines around an insect. Yet they are also small enough to remain airborne for considerable distances.

The original Inventors' Model No. 1 of the Hochberg-LaMer Insecticide Aerosol Generator, capacity of only 20 gallons of emulsion per hour, was used in all of the field tests reported herein. Later experiments are reported elsewhere on larger models.

The field tests with the inventors' model have shown that for adult mosquito control downwind to distances of 5,000 feet in open country and 1,000 feet in forested areas, an output of 15 gallons of emulsion (50 parts of oil–50 parts water by volume—DDT content being 10 per cent of the oil by weight) per 1,000 feet of front will suffice. This corresponds to a dosage, in terms of solid DDT, of 5 pounds of DDT per 1,000 feet of front. Front is the distance covered by the aerosol generator. For the same output, mosquito larvae are killed to distances of 1,500 to 2,000 feet in open country and 500 to 1,000 feet in forested areas. Thus about 60 pounds of DDT disseminated in the form of aerosol will treat one square mile of open country for larvae mosquitoes and 2 square miles for adults. This corresponds to an expenditure of about 0.1 pound DDT per acre of open country for larval control and about 0.05 pound DDT per acre for adult control. For forested areas, about 0.2 pound DDT per acre will be required for larval and adult control.

Conclusions: Aerosols formed by dispersing oil containing DDT can be effectively employed in the field for mosquito control operations. Aerosol treatment will kill adult *Anopheles* in tree holes, hollow logs and other natural resting places.

A dosage of 15 gallons, of 50 oil–50 water emulsion by volume and containing an amount of DDT equal to 10 per cent of the weight of the oil, per 1,000 feet of front will obtain effective adult control up to about a mile downwind in open country and to about 1,000 feet in forested areas.

This same dosage will obtain practical larval control up to about 2,000 feet in open country and from 500 to 1,000 feet in forested areas.

For adult control, a 10 micron diameter aerosol can be used regardless of wind velocity and terrain. For larval control, however, the particle size should be increased for winds of 3 or greater miles per hour (except, of course, for larval control in forested areas where 10 mu must be used to obtain penetration).

Operations should be carried out under meteorological conditions wherein the cloud remains close to the ground since insects to be controlled are to be found, in general, within 15 feet from the ground.

The time and mode of treatment should be selected with reference to the habits of the particular species to be controlled.

Residual effects are negligible for the recommended output of 15 gallons per 1,000 feet given above but a significant protective period may be obtainable with short flight mosquitoes.

The lethal dosage varies considerably for different insects and the above recommended dosage will *not* kill "all insects." The recommended dosage did not harm the fish of Sykes Creek, Florida.—Authors' Abstract and Conclusions.

MOSQUITO CONTROL. State of California Department of Public Health, Bulletin No. 44. (Revised 1945.) 55 pp.—In 55 pages of carefullly selected facts the entire mosquito control problem is considered, and much specific information is presented which is of value not only in California, but elsewhere where mosquito control is practiced or contemplated. According to a note on page 55, the original manuscript for this Bulletin was prepared by Harold F. Gray, which in itself assures an authoritative presentation. This presentation is made, in general, along the lines followed in the book *Mosquito Control* by by W. B. Herms and H. F. Gray (comprehensively reviewed in MOSQUITO NEWS, Vol. 4, No. 4, Dec. 1944, pp. 142–144), although necessarily much more condensed and omitting or barely mentioning many details that are discussed at length in the book.

The section on "Special Mosquito Control Problems" includes reference to and short descriptions of control measures for such special areas as rice fields, duck clubs, reservoirs and ponds, intermittent streams, garden pools, cisterns, barrels, tin cans, cesspools, septic tanks, privies,

defective plumbing, and dairy drains. These and the information on DDT will be of special value to persons who may have individual control problems in areas where there are no publicly supported mosquito control programs, as well as in areas where the intelligent co-operation of individuals can be of great assistance to officially constituted control agencies.

The other information on specific control measures is classified under the headings "Fresh Water Mosquito Control" and "Salt Marsh Mosquito Control." There are also sections headed "Malaria and Other Diseases Transmitted by Mosquitoes," "The Control of Malaria," "The Mosquitoes of California," "Finding Mosquito Breeding Places," "Control of Mosquitoes," "Mosquito Control Agencies," and "Insects Sometimes Mistaken for Mosquitoes." D. L. Collins

Experiments to Determine Potential Mosquito Vectors of Wuchereria Bancrofti in the Continental United States.—Walter L. Newton, Willard H. Wright, and Ivan Pratt. Amer. Jour. Trop. Med., May 1945.—It is apparent from the number of dissections made and the care exercised in evaluating the development of the larvae recovered that the authors have made an intensive study of this problem. In view of the limited and fragmentary information available in the literature prior to this study, the results reported upon give the first conclusive data on the potentiality of some of our more common species of mosquitoes as vectors of *Wuchereria bancrofti.*

While the likelihood of the filariid's becoming established in this country is a subject for considerable discussion, the fact remains that a focus of infection presumably brought from Africa by slaves persisted in Charleston, South Carolina, for several years, only recently dying out. In addition, it is a well-known fact that many of our armed and civilian personnel have been and will be stationed abroad in filarious foci. Although the chances of their reintroducing the parasite in sufficient concentration in one area to establish a focus are admittedly slight, nevertheless, past experience has proven the existence of such a possibility.

The data presented by the authors support the following conclusions:

1. *Culex quinquefasciatus, C. tarsalis, Psorophora confinnis,* and *Anopheles albimanus* could become excellent vectors of *Wuchereria bancrofti* should the proper conditions for its spread prevail.
2. *Culex nigripalpus, Aedes aegypti,* and *A. triseriatus* might spread the filaria, although their low infectibility rates preclude their becoming major vectors.
3. *Aedes sollicitans, A. taeniorhynchus. A. vexans, Anopheles punctipennis,* and *A. quadrimaculatus* apparently could not serve as vectors.

Extra significance may be attached to this information when it is realized that at the present time there is no effective treatment known for the parasite and that the only recourse is, therefore, the control of the mosquito vectors.

A. D. Hess

House Spraying With D.D.T. and With Pyrethrum Extract Compared: First Results. By R. Senior White 1945. Malaria Inst. India, Jour. 6(1):83-87, June, 1945.

Comparative tests of house spraying with DDT and pyrethrum in highly malarious villages in the Jeypore Hills region in India were conducted by the author, December 1944 to April 1945. This is a preliminary report on work which is being continued. The village Jimidiguda with about 50 houses and a spleen rate of 87.8 percent was sprayed with DDT while the village of Chatikona (spleen rate 98.0 percent) and adjacent railway colony were sprayed with pyrethrum extract. The village of Bariguda (spleen rate of 92.7 percent) was used as a check.

The *Anopheles* present were *fluviatilis, varuna, minimus, culicifacies, aconitus* and *jeyporiensis,* the first three being the local malaria vectors.

In 1942 expensive antilarval measures, carried out with indifferent results for several years in the railway colony, were entirely abandoned in favor of pyrethrum spraying 6 days a week. Pyrethrum supplies were too short to permit daily spraying of the houses in the larger program. Therefore the applications were made twice a week, first skipping two and then three days between sprayings and employing 50 percent more of the pyrethrum extract. In the earlier work ½ ounce of pyrethrum extract (strength not given) was applied per 1000 cubic feet. Results of the earlier work indicated that mosquitoes might be coming into the railroad colony from the village of Chatikona, ¼ mile away, and it was therefore thought necessary to extend the spraying operations to that village.

The 48 houses in the village of Jimidiguda were sprayed with a 5 percent solution of DDT in grade III kerosene by means of a De Vilbiss paint gun, set to give as coarse a spray as possible. About 1 quart of solution was applied per 1000 square feet. The wall surface, outdoor verandahs, roofs as far as accessible from below, but not the floors, were sprayed till wet. Two spray guns served by hand pressure sprayers covered the 48 houses in 3 days on the first round and one spray outfit took 7½ days to spray 50 houses on the second treatment, including the spraying of the string cots which, with their *Cimex,* were removed by the natives at the first treatment. The houses apparently have mudded and whitewashed walls and many have bamboo floored lofts.

Each week mosquito catches and dissections were made. These showed that the DDT residual spraying prevented infection in the important vector species for 8 weeks and materially reduced their density. Pyrethrum spraying 6 days each week reduced density and longevity

sufficiently to inhibit gland infection. Density reduction was much less than where DDT was used. Pyrethrum spraying twice a week was ineffective in reducing density and infectivity.

It was found that the cost of the DDT treatment, figuring the DDT at $1.00 per pound, was 20 to 25 times cheaper per capita per week than pyrethrum. This was during December to February, a period of heavy though not maximal transmission.—Fred C. Bishopp, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture.

DETAILS OF THE PROCEDURE ADOPTED IN MAINTAINING A LABORATORY COLONY OF FLUVIATILIS. By Badri Nath Mohan. Journal Malaria Institute of India, Vol. VI, No. 1, June, 1945, pages 75–76.

A vigorous colony of *Anopheles fluviatilis* has been maintained for more than a year and the author previously kept a colony for twenty-one months and then allowed it to die. Start was made with wild-caught females confined individually in 4 x 2 cm. tubes plugged with moist cotton covered with filter paper and inserted in a petri dish. The eggs were laid on the filter paper.

The eggs were floated in cork rings in enamel basins. Hay infusion and small quantities of litmus milk, two parts, and dehydrated blood serum, one part, or dried brewer's yeast were used as food. The water was aerated daily with a rubber syringe. Lining the basins with mud, dried in the sun reduced mortality.

The pupae were put in a bowl of clear water and kept in the colony stage. This cage was 2 x 2 x 2 feet with a bottom of sheet tin and sides and top of fiber-board except for a sleeve and a 2 x 2 inch screened hole in the top. This was kept in a larger wooden cage and high humidity maintained. Ten per cent glucose water was supplied, and a rabbit with shaved back was introduced nightly into the colony cage. Females took blood reluctantly from rabbits, guinea pigs and fowls but more freely from monkeys. They fed on rabbits more readily after their first oviposition. Bowls of water were supplied for egg laying. The females preferred earth lined vessels for oviposition.

Mating took place only in the presence of blue light. It was felt necessary to have a large number of females in the colony to insure the presence of multiparous individuals and therefore satisfactory feeding and oviposition.—Fred C. Bishopp, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture.

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DIRECTORY OF MANUFACTURERS AND SUPPLIERS

FOREWORD

An effort has been made to compile for our members, as in previous years, listings of suppliers in the various fields relative to mosquito control. The Committee has not endeavored to list all the dealers under the various headings, but has tried to list the principal dealers in each field.

The Committee assumes no responsibility for omissions, corrections or errors in the listings due to the vast undertaking of a job of this kind in a minimum amount of space. Members who find omissions, corrections or errors in listings will render a great service to the Committee and the Association by advising the Business Manager.

Credit is given to ENTOMA for some of the many references in compiling this directory. Listings of firms in this directory do not constitute endorsements of the products. The names of advertisers in MOSQUITO NEWS appear in **bold face** type.

THE DIRECTORY COMMITTEE

James T. Hart, Jr., Chairman ..... Morris Plains, N. J.
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H. F. Gray ..... Berkeley, Cal.
Don M. Rees ..... Salt Lake City, Utah
J. Lyell Clarke ..... Lyons, Ill.
C. T. Williamson, Business Manager ..... Yaphank, L. I., N. Y.

A. CONSTRUCTION EQUIPMENT AND SUPPLIES:

Construction Pumps:

Aldrich Pump Co., Allentown, Pa.
American Marsh Pumps, Inc., 63 W. Jackson, Chicago, Ill.
American Steam Pump Co., Battle Creek, Mich.
American Well Works, Aurora, Ill.
Atlas Brass Foundry Co., Columbus, Ohio.
Aurora Pump Co., Columbus, Ohio.
Barnes Mfg. Co., Mansfield, Ohio.
Blackmer Pump Co., Grand Rapids, Mich.
Dayton-Dowd Co., Quincy, Ill.
Decatur Pump Co., Decatur, Ill.
Deming Co., Salem, Ohio.
Dempster Mill Mfg. Co., Beatrice, Neb.
Domestic Engine & Pump Co., Shippensburg, Pa.
Douglas, W. & B., Pump Co., 6245 State Rd., Philadelphia, Pa.
Everite Pump & Mfg. Co., Inc., Lancaster, Pa.
Fairbanks Morse & Co., 600 S. Michigan Ave., Chicago, Ill.
Flint & Walling Mfg. Co., Kendallville, Ind.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Hinman, D. A., & Co., Sandwich, Ill.
Howell, R. R., & Co., Minneapolis, Minn.
Hudson, H. D., Mfg. Co., 589 E. Illinois, Chicago, Ill.
Humphreys Mfg. Co., Mansfield, Ohio.
Koontz, C. K., Co., Investment Bldg., Pittsburgh, Pa.
Lobee Pump & Machinery Co., Inc., 129 Dearborn, Buffalo, N. Y.
Midco Mfg. & Distributing Co., Inc., S. 13th & Kentucky Ave., Sheboygan, Wis.
Myers, F. E., & Bro. Co., 902 Church, Ashland, Ohio.
Novo Engine Co., Lansing, Mich.
Roper, Geo. D. Corp., Everett, Mass.
Red Jacket Mfg. Co., Davenport, Iowa.
Sexton Can Co., Everett, Mass.
Stewart Mfg. Co., Waterloo, Iowa.
Sta-Rite Products, Inc., Delavan, Wis.
Tokheim Oil Tank & Pump Co., Fort Wayne, Ind.
Viking Pump Co., Cedar Falls, Iowa.

Construction Pumps—(Continued)

Waterloo Construction Machinery Co., Waterloo, Iowa.
Wisconsin Motor Corp., Milwaukee, Wis.
Worthington Pump & Machinery Corp., Harrison, N. J.

Engines, Gasoline and Diesel:

Aermotor Co., 2500 Roosevelt Rd., Chicago, Ill.
Associated Manufacturers, Inc., Waterloo, Iowa.
Baker Mfg., Evansville, Wis.
Briggs & Stratton Corp., Milwaukee, Wis.
Buda Co., Harvey, Ill.
Caterpillar Tractor Co., Peoria, Ill.
Charter Gas Engine Co., Sterling, Ill.
Cummins Engine Co., Columbus, Ohio.
Deere, John, Tractor Co., Waterloo, Iowa.
Eagle Mfg. Co., Appleton, Wis.
Fairbanks Morse & Co., 600 S. Michigan Ave., Chicago, Ill.
Fairmont Railway Motors, Inc., Fairmont, Minn.
Fuller & Johnson Mfg. Co., Madison, Wis.
Galloway Co., Inc., Waterloo, Iowa.
Hill Diesel Engine Co., 238 Mill St., Lansing, Mich.
International Harvester Co., Inc., 180 N. Michigan Ave., Chicago, Ill.
Jacobsen Mfg. Co., 763 Washington Ave., Racine, Wis.
Johnson Motors, 1830 Pershing Rd., Waukegan, Wis.
Midco Mfg. & Distributing Co., Inc., S. 13th & Kentucky Ave., Sheboygan, Wis.
Novo Engine Co., Lansing, Mich.
Ottawa Mfg. Co., Ottawa, Kans.
Scott & Ewing Co., Bluffton, Ohio.
Superior Engine Co., Springfield, Ohio.
United Engine Co., Lansing, Mich.
Universal Motor Co., Oshkosh, Wis.
Waterloo Construction Machinery Co., Waterloo, Iowa.
Witte Engine Works, Kansas City, Mo.

Heavy Hardware:

American Hoist & Derrick Co., St. Paul, Minn.
American Logging Tool Co., Evart, Mich.
Boston & Lockport Block Co., Boston, Mass.
Chance Co., Centralia, Mo.
Dobbie Foundry & Machine Co., Niagara, N. Y.
Fulton Iron Works, Detroit, Mich.
Hansen & Yorke Co., Inc., 88–90 Warren St., New York City.
Laughlin, Thomas, Co., 199 Fore St., Portland, Me.
Link Belt Co., Pacific Division, 402 St. Paul Ave., San Francisco, Calif.
McMillans, W. H., Sons, 49 South St., New York, N. Y.
Madesco Tackle Block Co., Easton, Pa.
Maine Steel Co., Portland, Me.
Merriman Bros., Boston, Mass.
Michigan Engine Valve Co., Detroit, Mich.
Newhall Chain Forge & Iron Co., 48 West Broadway, New York, N. Y.
Ney Mfg. Co., Pittsburgh, Pa.
Roebling, John A., Sons Co., Trenton, N. J.
Sauerman Bros., Inc., 438 S. Clinton St., Chicago, Ill.
Starline, Inc., Harvard, Ill.
Taylor-Parker Co., Inc., 47 Commercial Place, Norfolk, Va.
Tidewater Supply Co., Inc., 36 Commercial Place, Norfolk, Va.
United States Steel Supply Co., 1319 Wabansia Ave., P. O. Box MM, Chicago, Ill.
Upson-Walton Co., 1280 West 11th St., Cleveland, Ohio.
Wilcox Crittenden & Co., Inc., 77 S. Main, Middletown, Conn.

Heavy Machinery and Equipment:

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steel Wire Co., 350 Fifth Ave., New York, N. Y.
Austin-Western Road Machine Co., Aurora, Ill.
Baker Mfg. Co., 1000 Stanford Ave., Springfield, Ill

Heavy Machinery and Equipment—(Continued)

Bay City Shovels, Inc., 2611 Center Ave., Bay City, Mich.
Brooks, R. E., Co., 50 Church St., New York 7, N. Y.
Caterpiller Tractor Co., Peoria, Ill.
Columbia Steel Tank Co., Kansas City 7, Mo.
Consolidated Wagon & Machine Co., Salt Lake City, Utah.
Crane Co., 1225–1st., N.W., Washington, D. C.
Cummings Co., 194 Frelinghuysen Ave., Newark, N. J.
Dale & Rankin, Inc., 113 Frelinghuysen Ave., Newark, N. J.
Dolge, C. B., Co., Westport, Conn.
Gray Concrete Pipe Co., Jefferson Davis Hwy., Arlington, Va.
Harnischfeger Corp., Milwaukee, Wis.
Hayward, The, Co., 50 Church St., New York, N. Y.
Hughes-Keenan Co., 1934 Smith St., Mansfield, Ohio.
Jaeger Machine Co., Columbus, Ohio.
Johnson & Dealman, Inc., 225 South St., Newark, N. J.
Killefer Mfg. Corp., Ltd., 5525 Downey Rd., Los Angeles, Calif.
Leschen & Son Rope Co., 90 West St., New York, N. Y.
Lidgerwood Hoist, Elizabeth, N. J.
Lima Locomotive Works, Inc., Main & Market Sts., Lima, Ohio.
Loomis, C. H., & Co., 154 First St., New York, N. Y.
MacWhyte Company, 2906 14th Ave., Kenosha, Wis.
Malvese, Geo., Jericho Trp., Mineola, L. I., N. Y.
Maryland Culvert & Pipe Co., Baltimore, Md.
Mente, John M., 15 Lafayette Ave., Kenilworth, N. J. "Concrete Pipe."
Noland Co., Inc., 136 K St., N.E., Washington, D. C.
Northwest Engineering Co., 28E Jackson Blvd., Chicago 4, Ill.
Owens Buckets, Cleveland, Ohio.
Page Engineering, Summit, Ill.
Patton Tractor & Equipment Co., 1056 N. Kolmar, Chicago, Ill.
Penn, H. O., Machinery Co., Inc., 140th St., East River, New York, N. Y.
Peterson, Arthur D., Co., Inc., 420 Lexington Ave., New York, N. Y.
Roebling, John A., & Son Co., Trenton, N. J.
Ryerson, Joseph T., & Co., Inc., 2558 West 16th, Chicago, Ill.
Seashore Machine Works, Atlantic City, N. J.
Smith Tractor & Equipment Co., Irvington, N. J.
Stanhope, R. C., Inc., 60 East 42nd St., New York, N. Y.
Stortz, John, & Son, Inc., 210 Vine St., Philadelphia, Pa.
Tractor & Equipment Co., 3515 West 51st St., Chicago, Ill.
Walke, Henry, Co., 407 Union St., Norfolk, Va.
Wickwire Spencer Steel Co., 500 5th Ave., New York 18, N. Y.

Rope:

American Mfg. Co., Noble & West St., Brooklyn, N. Y.
Broderick & Bascom Rope Co., St. Louis, Mo.
Carpenter, George B., & Co., 440 N. Wells, Chicago, Ill.
Cating Rope Works, Inc., Maspeth, N. Y.
Columbian Rope Co., 352 Genesee, Auburn, N. Y.
Fitler, Edwin H., Co., 5625 Tacony, Philadelphia, Pa.
Hooven & Allison Co., Xenia, Ohio.
Kelly, R. A., Co., Xenia, Ohio.
Jackson, Thos., & Son Co., Reading, Pa.
Johnson-Pickett Rope Co., 120 Wall St., New York, N. Y.
Leschen, A., & Sons Rope Co., St. Louis, Mo.
New Bedford Cordage Co., 233 Broadway, New York, N. Y.
Peoria Cordage Co., Peoria, Ill.
Plymouth Cordage Co., North Plymouth, Mass.
Portland Cordage Co., Portland, Ore.
Rinek Cordage Co., Easton, Pa.
Ruggs, E. T., & Co., Newark, Ohio.
St. Louis Cordage Mills, 1715 S. 11th St., St. Louis, Mo.
Tubbs Cordage Co., San Francisco, Calif.
Upson-Walton Co., 1280 West 11th St., Cleveland, Ohio.
Wall Rope Works, Inc., 48 South St., New York, N. Y.
Waterbury Rope Co., Inc., 401 Park Ave., Brooklyn, N. Y.
Whitlock Cordage Co., 46 South St., New York, N. Y.

Rubber, Boots:

Beacon Falls Rubber Shoe, Inc., Beacon Falls, Conn.
Cambridge Rubber Co., 748 Main, Cambridge, Mass.
Converse Rubber Co., Malden, Mass.
Goodall Rubber Co., 7 S. 36th St., Philadelphia, Pa.
Goodyear Footwear Co., 44 Warren, Providence, R. I.
Goodyear Glove Rubber Co., 300 Second St., San Francisco, Calif.
Hood Rubber Co., Inc., Watertown, Mass.
Mishawaka Rubber & Woolen Mfg. Co., Mishawaka, Ind.
Montague Rubber Co., 116 Randolph St., Norfolk 10, Va.
Servus Rubber C., 238 Broadway, New York, N. Y.

Rubber, Hose and Supplies:

Acme Rubber Co., 90 West Broadway, New York, N. Y.
Alliance Hose & Rubber Co., 30 S. Jefferson, Chicago, Ill.
Amazon Hose & Rubber Co., 130 N. Jefferson, Chicago, Ill.
Atlantic Mfg. Co., Wilmington, Del.
Boston Woven Hose & Rubber Co., Cambridge, Mass.
Cincinnati Rubber Mfg. Co., (Norwood) Cincinnati, Ohio.
Clark & Barlow Hardware Co., 123 W. Lake St., Chicago, Ill.
Columbia Steel Tank Co., Kansas City 7, Mo.
Continental Rubber Works, Erie, Pa.
De Vilbiss Co., Toledo, Ohio.
Diamond Rubber Co., Inc., Akron, Ohio.
Durst Mfg. Co., Inc., 468 Broadway, New York, N. Y.
Eclat Rubber Co., Akron, Ohio.
Franklin Rubber Corp., 434 E. Allegany Ave., Philadelphia, Pa.
Globe Rubber Works, Inc., Boston, Mass.
Goodall Rubber Co., 7 S. 36th St., Philadelphia, Pa.
Goodrich, B. F., Co., Akron, Ohio.
Goodyear Glove Rubber Co., 300 Second St., San Francisco, Calif.
Goodyear Tire & Rubber Co., Akron, Ohio.
Hewitt Rubber Corp., 240 Kensington Ave., Buffalo, N. Y.
Hodgman Rubber Co., Framingham, Mass.
Home Rubber Co., Trenton, N. J.
Imperial Brass Mfg. Co., 1200 W. Harrison St., Chicago, Ill.
Jenkins Bros., 80 White, New York, N. Y.
Keystone Brass & Rubber Co., Broad & Lehigh Ave., Philadelphia, Pa.
Lee Tire & Rubber Co., Conshohocken, Pa.
Manufactured Rubber Products Co., 8 North Front, Philedelphia, Pa.
New York Rubber Corp., Beacon, N. Y.
Peterson, Arthur D., Co., Inc., 420 Lexington Ave., New York, N. Y.
Pioneer Rubber Mills, San Francisco, Calif.
Quaker Rubber Corp., 4915 Comly, Philadelphia, Pa.
R-C-A- Rubber Co., Akron, Ohio.
Reliance Rubber Mills, San Francisco, Calif.
Republic Rubber Co., Youngstown, Ohio.
Safety Fire Extinguisher Co., 291 Seventh Ave., New York, N. Y.
Schacht Rubber Mfg. Co., Huntington, Ind.
Snyder, M. L., & Sons, Boston & Jasper, Philadelphia, Pa.
Tidewater Supply Co., Inc., 47 Commercial Place, Norfolk 10, Va.
Thermoid Rubber, Div. of Thermoid Co., Trenton, N. J.
Thurston, C. E., & Son, 32 Commercial Place, Norfolk 10, Va.
Tillinghast, B. C., Rubber Co., Inc., 236 Market, Philadelphia, Pa.
Tyer Rubber Co., Railroad, Andover, Mass.
United States Rubber Co., 1230 Avenue of the Americas, New York, N. Y.
Western Fire Equipment Co., 69 Main St., San Francisco, Calif.
Williams-Bowman Rubber Co., 1939 S. 54th Ave., Cicero, Ill.

Tanks, Oil Storage:

Adamson Mfg. Co., East Palestine, Ohio.
American Gas Machinery Co., Inc., Albert Lea, Minn.
Bard Mfg. Co., 213 W. Butler, Bryan, Ohio.
Beatrice Steel Tank Co., Beatrice, Neb.
Berkeley Steel Construction Co., 2nd & Camelia St., Berkeley, Calif.

Tanks, Oil Storage—(Continued)

Biggs Boiler Works Co., Akron, Ohio.
Bowser, S. F., & Co., Fort Wayne, Ind.
Boyle Mfg. Co., 5100 Santa Fe Ave., Los Angeles, Calif.
Caldwell, W. E., Co., Inc., Louisville, Ky.
Chicago Steel Tank Co., 6400 West 66th St., Chicago, Ill.
Codd, E. J., Co., Baltimore, Md.
Columbian Steel Tank Co., Kansas City 7, Mo.
Denver Equipment Co., 1400 17th St., New York, N. Y.
Des Moines Steel Tank Co., 421 S. Spring, Independence, Mo.
Devine, J. P., Mfg. Co., Inc., Mt. Vermont, Ill.
Dover Boiler Works Co., Dover, N. J.
Eastern Steel Tank Corp., 200 Stewart Ave., Brooklyn, N. Y.
Economic Steel Rack Co., Everett, Mass.
Emerson-Scheuring Tank Co., Indianapolis, Ind.
Erie City Iron Works, Erie, Pa.
Farquhar, A. B., Co., Ltd., York, Pa.
Freeland Steel Tank Co., Portage, Wis.
Gilbert & Barker Mfg. Co., Springfield, Mass.
Graver Tank & Mfg. Corp., East Chicago, Ill.
Hamler Tank & Boiler Co., Chicago, Ill.
Hammond Iron Works, Warren, Pa.
Harry, O. K., Steel Co., 2337 Papin St., St. Louis, Mo.
Hastings Equity Steel Bin Mfg. Co., Hastings, Neb.
Koven, L. O., & Bros., 154 Ogden Ave., Jersey City, N. J.
Lancaster Iron Works, Inc., Lancaster, Pa.
Littleford Bros., Cincinnati, Ohio.
McDonough Steel Co., 800 75th Ave., Oakland, Calif.
Mead-Penn Iron Works, Meadville, Pa.
National Enameling & Stamping Co., 270 N. 12th, Milwaukee, Wis.
Petroleum Iron Works Co., Sharon, Pa.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Prentiss Wabers Products Co., Wisconsin Rapids, Wis.
Quaker City Iron Works, Philadelphia, Pa.
Sexton Can Co., Everett, Mass.
Stanhope, R. C., Inc., 60 East 42nd St., New York, N. Y.
Struthers-Wells Co., Warren, Pa.
Vernier Mfg. Co., Cedar Rapids, Iowa.
Wall, P., Mfg. Supply Co., 3126–3166 Preble Ave., Pittsburgh, Pa.
Wood, John, Mfg. Co., Inc., Conshohocken, Pa.

Tools, Hand:

American Fork & Hoe, 1623 Euclid Ave., Cleveland, Ohio.
Ames-Baldwin-Wyoming Co., Parkersburg, W. Va.
Ames, Oliver, & Sons, North Easton, Mass.
Bridgeport Hardware Mfg. Corp., Bridgeport, Conn.
Clark & Barlow Hardware Co., 123 W. Lake St., Chicago, Ill.
Collins Co., Collinsville, Conn.
Cornwell Quality Tools Co., 1016 N. Cleveland St., Mogadore, Ohio.
Consolidated Wagon & Machine Co., Salt Lake City, Utah.
Council Tool Co., Wananish, Wis.
Emerson & Stevens Mfg. Co., Oakland, Maine.
Federal Hardware, 447 Greenwich St., New York, N. Y.
Geyer Mfg. Co., Rock Falls, Ill.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hamlin Metal Products Co., 58 W. Exchange, Akron, Ohio.
Hawkins Equipment Co., 1475 Thomas St., Memphis, Tenn.
Hays Supply Co., Memphis, Tenn.
Hibbard, Spencer, Bartlett, Chicago, Ill.
Ingersoll Steel Disc Co., Newcastle, Ind.
Iwan Bros., South Bend, Ind.
King Axe & Tool Co., Oakland, Me.
Magor Car Corp., 50 Church St., New York, N. Y.
Manahan, Juiland, 3510 Bergenline Ave., Union City, N. J.
Mann Edge Tool Co., Oakland, Me.

Tools, Hand—(Continued)

Nicholson File Co., Providence, R. I.
Peavey Mfg. Co., Brewer, Me.
Peck Stow & Wilcox Co., Southington, Conn.
Plumb Fayette, R., Inc., Philadelphia, Pa.
Riechman Crosby Co., 223 Front St., Memphis, Tenn.
Rixford Mfg. Co., Highgate, Vt.
Salt Lake Hardware & Machine Co., Salt Lake City, Utah.
Sears, Roebuck & Co., Philadelphia, Pa.
Seashore Machine Works, Atlantic City, N. J.
Snow & Nealley Co., Bangor, Me.
Stanley Works, New Britain, Conn.
Underhill Clinch & Co., 84 White St., New York, N. J.
Union Fork & Hoe Co., Columbus, Ohio.
Vaughan & Bushnell Mfg. Co., Chicago, Ill.
Walker-Turner Co., Plainfield, N. J.
Warren Axe & Tool, Warren, Pa.
Watters & Martin, Inc., 110 W. Water St., Norfolk, Va.

Tools, Power:

Arcade Mfg. Co., Freeport, Ill.
Atlas Press Co., 841 N. Pitcher, Kalamazoo, Mich.
Barnes, W. F. & John, Co., Rockford, Ill.
Beebe Bros., Inc., Seattle, Wash.
Black & Decker Mfg. Co., Towson 4, Md.
Blue Star Products, Fairfield, Iowa.
Boice-Crane Co., 930 Central Ave., Toledo, Ohio.
Carter, R. L., Co., New Britain, Conn.
Chicago Wheel & Mfg. Co., 1101 W. Monroe, Dept. EE, Chicago, Ill.
Cincinnati Tool Co., Norwood, Cincinnati 12, Ohio.
Delta Mfg. Co., 650 E. Vienna Ave., Milwaukee, Wis.
Double A Products Co., Inc., Manchester, Mich.
Dremel Mfg. Co., Racine, Mich.
Duro-Metal Products Co., 2651 N Kildare Ave., Chicago, Ill.
Ephrata Mfg. Co., Ephrata, Pa.
Excel Auto Radiator Co., 320 East 21st St., Chicago, Ill.
Foredom Electric Co., 27 Park Place, New York, N. Y.
General Electric Co., Homeworkshop Div., Nela Park, Cleveland, Ohio.
Groton, George, Machine Co., 1321 Racine St., Racine, Wis.
Heston & Anderson, Fairfield, Iowa.
Power King Tool Corp., 706 E. Market St., Warsaw, Ind.
Roemer, Wm. C., 656 Winthrop Ave., New Haven, Conn.
Schroeter Bros., St. Louis, Mo.
Shaw Tool Co., 725 N. 16th St., Milwaukee, Wis.
Snap-on Tools Corp., 8028 28th Ave., Kenosha, Wis.
Stanley Electric Tool Div., New Britain, Conn.
Syncro Devices, Inc., 3265 Bermuda Ave., Ferndale, Detroit, Mich.
Walker-Turner Co., Inc., 595 Berckman, Plainfield, N. J.
United States Steel Supply Co., 1319 Wabansia Ave., Chicago, Ill.
Yates-American Machine Co., Beloit, Wis.

Underwater Weed Cutters:

Mechanical:

Hockney, C. L., Silver Lake, Mich.

Manual:

Zimson Weed Saw, Ashhard Bros., P. O. Box 155, LaCanada, Calif.

Wire, Screen Cloth:

American Brass Co., Waterbury, Conn.
American Wire Fabrics Corp., 500 Fifth Ave., New York, N. Y.
Chase Brass & Copper Co., Waterbury, Conn.
Clinton Wire Cloth Co., Clinton, Iowa.
Cole-Roscoe Mfg. Co., South Norwalk, Conn.

Wire, Screen Cloth—(Continued)

Cyclone Fence Co., Waukegan, Ill.
Gilbert & Bennett Mfg. Co., Blue Island, Ill.
Hanover Wire Cloth Co., Hanover, Pa.
Heilig Bros. Co., Inc., York, Pa.
Jelliff, C. O., Mfg. Corp., Southport, Conn.
Jelliff, Geo. H., & Son, New Canaan, Conn.
Newark Wire Cloth Co., 351 Verona Ave., Newark, N. J.
New York Wire Cloth Co., 500 Fifth Ave., New York, N. Y.
Pennsylvania Woven Wire Co., 115 Washington, Lock Haven, Pa.
Pequot Wire Cloth Co., Inc., South Norwalk, Conn.
Reynolds Wire Co., Dixon, Ill.
Roeblings, John A., Sons Co., Trenton, N. J.
Rolock, Inc., Southport, Conn.
Seneca Wire & Mfg. Co., Fostorio, Ohio.
Smith, F. P., Wire & Iron Works, 2340 Claybourn Ave., Chicago, Ill.
Spargo Wire Co., Rome, N. Y.
Standard Fence Co., Oakland, Calif.
Tyler, W. S., Co., Cleveland, Ohio.
Wickwire Bros., Cortland, N. Y.
Wickwire Spencer Steel Co., 500 Fifth Ave., New York, N. Y.
Wright, G. F., Steel & Wire Co., Worcester, Mass.

B. EDUCATION:

Motion Picture Films, Mosquito:

Alameda Co. Mosquito Abatement Dist., Oakland, Calif.
American Film Center, Inc., 45 Rockefeller Plaza, New York, N. Y.
Bray Pictures, Inc., 729 Seventh Ave., New York, N. Y.
DeVry Films & Laboratories, 1111 Armitage Ave., Chicago 14, Ill.
Eastman Kodak, Rochester, N. Y.
Edited Pictures System, Inc., 330 West 42nd St., New York, N. Y.
Encyclopaedia Britannica Films, Inc., 1841 Broadway, New York 23, N. Y.
Iowa State College, Visual Instruction Service, Ames, Iowa.
Malaria Control in War Areas, U. S. P. H. S., 605 Volunteer Bldg., Atlanta 3, Ga.
Nassau Co. Mosquito Exterm. Comm., Rockville Centre, L. I., N. Y.
N. J. State Museum, Trenton, N. J.
T.V.A., Health Educ., & Information Services, Chattanooga, Tenn.
U. S. Dept. of Agriculture, Washington, D. C.
U. S. Public Health Service, Washington, D. C.
University of Utah, Salt Lake City, Utah.

Photographic Equipment and Supplies:

Agfa Ansco Corp., Binghamton, N. Y.
American Bolex Co., Inc., 155 East 44th St., New York, N. Y.
American Optical Co., 1940 Thomas St., South Bridge, Mass.
Argus, Inc., Ann Arbor, Mich.
Bell & Howell Co., 7100 McCormick Rd., Chicago 45, Ill.
Candid Camera Corp. of America, 844 W. Adams, Chicago, Ill.
Clay-Adams Co., 44 East 23rd St., New York 10, N. Y.
College Pharmacy, New Brunswick, N. J.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
Eastman Kodak Co., Rochester, N. Y.
Eastman Kodak Stores, 133 N. Wabash, Chicago, Ill; New York, N. Y.; Philadelphia, Pa.
Folmer Graflex Corp., Rochester, N. Y.
Kaltman, L., & Sons, 305 Washington St., Newark, N. J.
Keystone Mfg. Co., 288 A, Boston, Mass.
Leitz, E., Inc., 730 Fifth Ave., New York 19, N. Y.
Monarch Mfg. Co., 711 W. Lake, Chicago, Ill.
Mostow Co., Merchandise Mart, Chicago, Ill.
Murphy, Inc., 57 E. Eighth St., New York, N. Y.
Revere Camera Mfg. Co., 320 East 21, Chicago, Ill.
Rolls Camera Mfg. Co., 1414 S. Wabash Ave., Chicago, Ill.
Sobotaka, Erie, 15 East 40th St., New York 16, N. Y.

Photographic Equipment and Supplies—(Continued)

Society for Visual Education, Inc., East Ohio St., Chicago, Ill.
Superior Products Corp., 599 Essex, Lynn, Mass.
Universal Camera Corp., 32 West 23rd St., New York, N. Y.
Utility Mfg. Co., 40 West 25th St., New York, N. Y.
Willoughby's, 110 West 32nd St., New York, N. Y.

Photographs of Insects:

Microphoto, 2404 W. Seventh St., Los Angeles, Calif.
Vishniac, Roman, 152 West 76th St., New York, N. Y.

Publishers of Reference Books, Mosquito:

American Assoc. for the Advancement of Science, Washington, D. C.
American Assoc. of Econ. Entomologists, College Park, Md.
American Public Health Assoc., 1790 Broadway, New York, N. Y.
Blakiston, The, Co., Philadelphia 5, Pa.
Carnegie Institute, Washington, D. C.
Commonwealth Fund, 41 East 57th St., New York, N. Y.
Comstock Publishing Co., Inc., Roberts Pl.. Ithaca, N. Y.
Gorham Press, Boston, Mass.
Macmillan Co., 60 Fifth Ave., New York 11, N. Y.
McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y.
National Malaria Society, Box 997, Tallahassee, Fla.
New Jersey Mosquito Exter. Assn., New Brunswick, N. J.
Potter & Moore, Lavender House, London, England.
Rutgers University Press, New Brunswick, N. J.
Saunders, W. B., & Co., Philadelphia, Pa.
Science Press Printing Co., Lancaster, Pa.
Thomas, C. C., Baltimore, Md.
U. S. Department of Agriculture, Washington, D. C.
U. S. Public Health Service, Washington, D. C.
University of California Press, Berkeley 4, Calif.

C. ENGINEERING INSTRUMENTS AND SUPPLIES, GENERAL:

Ainsworth, Wm., & Son, Inc., 2151 Lawrence, Denver, Colo.
Alteneder, Theo., & Sons, 1217 Spring Garden St., Philadelphia, Pa.
Brunning, Charles, Inc., 102 Reade St., New York, N. Y.
Dieterich-Post Co., 15 First St., San Francisco, Calif.
Dieterich-Post Co., 218 East 23rd St., New York, N. Y.
Dietzgen, Eugene, Co., 2425 N. Sheffield Ave., Chicago, Ill.
Dobbins Mfg. Co., Elkhart. Ind.
Fairchild Aerial Surveys, Inc., 21–21 41st Ave., Long Island City, N. Y.
Gurley, W. & L. E., Troy, N. Y.
Keuffel & Esser Co., Hoboken, N. J.
Keuffel & Esser Co., 520 Dearborn, Chicago, Ill.
Lietz, A., & Co., 520 Montgomery St., San Francisco, Calif.
Pembroke Company, 22 E. Third St., Salt Lake City, Utah.
Photo-Blue Co., Ness Bldg., Salt Lake City, Utah.
Salt Lake Blue Print & Supply Co., Salt Lake City, Utah.
Shaw Blue Print Co., 9 Campbell St., Newark, N. J.
Warren-Knight Co., 136 N. 12th St., Philadelphia, Pa.
Wissler Instrument Co., Rochester, N. Y.

D. EQUIPMENT AND ACCESSORIES FOR THE APPLICATION OF INSECTICIDES:

Aerosol Dispensing Machinery:

Besler Corp., Emeryville 8, Calif.
DeVilbiss Co., 300 Phillips Ave., Toledo, Ohio.
Stewart-Warner Co., 1828 Diversey Parkway, Chicago, Ill.
Todd Corporation, 601 West 26th St., New York, N. Y.
Virginia Smelting Co., West Norfolk, Va.

Agitators:

Bartlett, C. O., & Snow Co., 6100 Harvard Ave., Cleveland, Ohio.
Denver Equipment Co., 1400 17th St., Denver, Colo.
Mixing Equipment Co., Inc., 1024 Garson Ave., Rochester 9, N. Y.
Porter, H. K., Co., Inc., 1932 Oliver Bldg., Pittsburgh 22, Pa.

Airplane Dusting and Spraying Service:

Adams Crop Dusting Co., 2295 Brooks, Box 722-A, Rt. 1, Memphis, Tenn.
Aerial Insecticiding Company, Cannon Mills Airport, Orlando, Fla.
Delta Air Corp., Bernstein Field, Monroe, La.
Industrial Aviation, M. B. Huggins, Jr., Huggins Field, Thomasville, S. C.
Jacks, Jack E., 1622 N. E. 2nd Ave., Miami 36, Fla.
Jordan Lederer Flying Service, Willmington, Del.
Murray, P. J., 701 G St., Oxnard, Calif.
Nealy, Roy, Pecatonia, Ill.
Southern Illinois Airways, Inc., P. O. Box 404, Marion, Ill.
Schroeder, J. L., Inc., 2214 Maroneal Blvd., Houston 5, Tex.
Tyler Flight Service, Amityville, N. Y.
Wilson Air Service, Seabrook Airport, Bridgeton, N. J.

Dust Mixers:

Ace Wood Products Co., 1891 West 25th St., Cleveland, Ohio.
Day, The J. H., Co., 1144 Harrison Ave., Cincinnati, Ohio.
Frost Insecticide Co., Arlington, Mass.
Messinger Mfg. Co., Tatamy, Pa.
Niagara Sprayer & Chemical Co., Inc., Middleport, N. Y.
Peerless Dust Gun Co., 5100 St. Clair Ave., Cleveland, Ohio.
Robinson Mfg. Co., Muncy, Pa.
Sprout, Waldron Co., 132 Sherman St., Muncy, Pa.

Dusters, Hand and Power:

Acmeline Mfg. Co., Traverse City, Mich.
Bean, John, Mfg. Co., Lansing 4, Mich.; San Jose, Calif.
Brown, E. C., Co., 900 Maple St., Rochester, N. Y.
Bullock, T. H., Mfg. Co., 3992 Bluestone Rd., Cleveland Heights, Ohio.
Burdett, Paul E., P. O. Box 241, Lombard, Ill.
California Bellows Works. 790 Brannan, San Francisco, Calif.
Crop-Saver Chemical Co., 2630 West Arthington St., Chicago 2, Ill.
Dobbins Mfg. Co., St. Paul, Minn.
Eureka Mower Co., Utica, N. Y.
Feeney Mfg. Co., Muncie, Ind.
"Friend" Mfg. Co., Gasport, N. Y.
Frost Insecticide Co., Arlington, Mass.
General Metalware Co., Minneapolis, Minn.
Houchin, Thos. W., Corp., 87 Ferry, Jersey City, N. J.
Hudson, H. D., Mfg. Co., 589 E. Illinois, Chicago, Ill.
Jaeckh Mfg., 3444 Colerain Ave., Cincinnati, Ohio.
Johnston Gear & Machine Works, Fresno, Calif.
Lowell Mfg. Co., Lowell, Mich.
Lut Zite, Div. Ridge Tool Co., Elyria, Ohio.
Master Fan Corp., 1321 Channing St., Los Angeles 21, Calif.
Messinger Mfg. Co., Tatamy, Pa.
Naco Mfg. Co. (Successors to Root Mfg. Co.), 7631 Roseberry Ave., Huntington Park, Los Angeles, Calif.
Niagara Sprayer & Chemical Co., Inc., Middleport, N. Y.
Olson Bros., Kingsburg, Calif.
Patterson, J. C., Jr., 410 Washington Bldg., Washington, D. C.
Peerless Dust Gun Co., 5100 St. Clair Ave., Cleveland, Ohio.
Shrink Manufacturing Co., Bucyrus, Ohio.
Simplex Co., McQueeney, Tex.
Smith, D. B., & Co., Utica, N. Y.
Stauffer Chemical Co., Apopka, Fla.
Superior Churn & Mfg. Co., Northville, Mich.
Universal Metal Products Co., Lowell, Mich.

Dusters, Hand and Power—(Continued)

Volume Sprayer Mfg. Co., Tulsa, Okla.
Wilson, Andrew, Inc., Springfield, N. J.

Oil Equipment and Supplies:

Blackmer Rotary Pump Co., Grand Rapids, Mich.
Carver Pump Co., 1056 Hersey Ave., Muscatine, Iowa.
Chase Brass & Copper Co., 1939 Rodney St., Waterbury, Conn. (Fittings.)
DeVilbiss Co., 300 Phillips Ave., Toledo, Ohio.
Field Force Pump Co., Pottstown, Pa.
Gould Pumps, Seneca Falls, N. Y.
Gray-Mills Co., 1948 Ridge Ave., Evanston, Ill. (Pumps.)
Porter, E. K., Co., Inc., 1932 Oliver Bldg., Pittsburgh 22, Pa. (Mixing Equipment.)
Renick and Mahoney, Inc., 114 Liberty St., New York, N. Y.
Spray Engineering Co., Somerville, Mass.
Spraying Systems Co., 4021 W. Lake St., Chicago 24, Ill. (Nozzles.)
Steel Drum & Barrel Co., Jacobus Ave. & Penn Rd., South Kearny, N. J.
Yeomans Bros. Co., 1469 N. Dayton St., Chicago 22, Ill. (Pumps.)

Respirators:

Acme Protection Equipment Co., 3616 Liberty Ave., Pittsburgh, Pa.
American Cyanamid & Chemical Co., 32C Rockefeller Plaza, New York 20, N. Y.
Miller Chemical Co., Omaha, Nebr.
Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa.
Wilson, Andrew, Inc., Springfield, N. J.

Sprayers, Hand:

Acmeline, Inc., Traverse City, Mich.
Aggeler & Musser Seed Co., 652 Matteo St., Los Angeles, Calif.
American Fluoride Corp., 151 West 19th St., New York, N. Y.
Beck, G. E., Inc., 6419 W. Addison, Chicago, Ill.
Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill.
Breuer Electric Mfg. Co., 5100 N. Ravenswood Ave., Chicago, Ill.
Brown, E. C., Co., 900 Maple St., Rochester, N. Y.
Bull, W. H., Co., Inc., 1950 N. 11th St., St. Louis 6, Mo.
Campbell-Hausfeld Co., 645 State St., Harrison, Ohio.
Chapin, R. E., Mfg. Works, Inc., Batavia, N. Y.
Crop-Saver Chemical Co., 2630 W. Arthington St., Chicago, Ill.
DeVilbiss Co., Toledo, Ohio.
Dobbins Mfg. Co., Elkhart, Ind.
Field Force Pump Co., Pottstown, Pa.
Food Machinery Corp., San Jose, Calif.
Frost Insecticide Co., Arlington, Mass.
Fumeral Co., Racine, Wis.
Goulard & Olena, Inc., 140 Liberty St., New York, N. Y.
Hudson, H. D., Mfg. Co., 589 E. Illinois St., Chicago 11, Ill.
Jaeckh Mfg. Co., 3444 Colerain Ave., Cincinnati, Ohio.
Lirio, P. E., Vineland, N. J.
Los Angeles Chemical Co., 1960 Santa Fe Ave., Los Angeles, Calif.
Lowell Sprayer Co., Lowell, Mich.; 589 E. Illinois St., Chicago 11, Ill.
Miller Chemical Co., Omaha 2, Nebr.
Myers, F. E., & Bros. Co., Ashland, Ohio.
Penna. Farm Bureau Cooperative Assoc., 3607 Derry St., Harrisburg, Pa.
Roediger, Paul O., P. O. Box 383, Princeton, N. J.
Simmons Paint Spray Brush Co., Dayton, Ohio.
Smith, D. B., & Co., Inc., Utica, N. Y.
Sprayco, Inc., 114 Central St., Somerville, Mass.
Volume Sprayer Mfg. Co., P. O. Box 76, Tulsa, Okla.
Western Fire Equipment Co., 69 Main St., San Francisco, Calif.
Wilson, Andrew, Inc., Springfield, N. J.

Sprayers, Electric:

Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill.
Breuer Electric Mfg. Co., 5100 N. Ravenswood Ave., Chicago, Ill.

Sprayers, Electric—(Continued)

Brown, W. R., Corp., 5724 Armitage Ave., Chicago, Ill.
Campbell-Hausfeld Co., 645 State St., Harrison, Ohio.
Crown Spray Gun Mfg. Co., 1218 Venice Blvd., Los Angeles, Calif.
Daisy Co., 507–11 East 16th St., Kansas City, Mo.
Dobbins Mfg. Co., Elkhart, Ind.
Dula Mfg. Co., Inc., 351 Atlantic Ave., Brooklyn, N. Y.
Electric Sprayit Co., 220 N. Broadway, Milwaukee, Wis.
Hudson, H D., Mfg. Co., 589 E. Illinois St., Chicago, Ill.
Metal Specialties Mfg. Co., 3208 Carroll Ave., Chicago, Ill.
Myers, F. E., & Bro. Co., Ashland, Ohio.
Saylor-Beall Mfg. Co., 1509 E. Philadelphia Ave., Detroit, Mich.
Tanglefoot, The, Co., Grand Rapids, Mich.

Sprayers, Paint:

Bean, John, Mfg. Co., Lansing 4, Mich.
Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill.
Brown, W. R., Corp., 5724 Armitage Ave., Chicago, Ill.
Brunner Mfg. Co., Utica, N. Y.
Champion Pneumatic Mach. Co., 8164 S. Chicago Ave., Chicago, Ill.
Crown Spray Gun Mfg. Co., 1218 Venice Blvd., Los Angeles, Calif.
DeVilbiss Co., 300 Phillips Ave., Toledo, Ohio.
Eclipse Air Brush Co., Inc., 3900 Park Ave., Newark, N. J.
Electric Sprayit Co., 1415 Illinois, Sheboygan, Wis.
Empire Compressor Mfg. Co., Inc., 2019 Central Ave., Cincinnati, Ohio.
Essick Mfg. Co., 1950 Santa Fe Ave., Los Angeles 21, Calif.
Gast Mfg. Co., Benton Harbor, Mich.
Hackney Chemical Co., Fresno, Calif.
Hudson, H. D., 589 E. Illinois, Chicago, Ill.
Johnston Gear & Machine Works, Fresno, Calif.
Kellogg Mfg. Co., Rochester, N. Y.
Macleod Co., 2232 Bogen, Cincinnati, Ohio.
Matthews, W. N., Corp., St. Louis, Mo.
Metal Specialties Mfg. Co., 3200 Carroll Ave., Chicago, Ill.
Milburn, Alexander, Co., 1416 W. Baltimore, Baltimore, Md.
Milwaukee Sprayer Mfg. Co., 2437 West Fond du Lac Ave., Milwaukee, Wis.
O. K. Machine Co., Inc., Fort Wayne, Ind.
Paasche Air Brush Co., 1909 Diversey Parkway, Chicago, Ill.
Saylor-Beall Mfg. Co., 1509 E. Philadelphia Ave., Detroit, Mich.
Sharpe Mfg. Co., 1324 S. Wall, Los Angeles, Calif.
Simmons Paint Spray Brush Co., Dayton, Ohio.
Sprayco, Inc., 114 Central St., Somerville, Mass.
U. S. Air Compressor Co., Cleveland, Ohio.

Sprayers, Power:

Bean, John, Mfg. Co., Lansing 4, Mich.
Beck, G. E., Inc., 6419 W. Addison, Chicago, Ill.
Binks Mfg. Co., Gasport, N. Y.
Browner Foundry & Machinery Co., Peru, Ill.
Campbell & Budling, San Jose, Calif.
Domestic Engine & Pump Co., Shippensburg, Pa.
Douglas, W. & B., Pump Co., 6245 State Rd., Philadelphia, Pa.
Electric Sprayit Co., 1415 Illinois, Sheboygan, Wis.
Farquhar, A. B., Co., Ltd., York, Pa.
Field Force Pump Co., Pottstown, Pa.
Food Machinery Corp., San Jose, Calif.
"Friend" Mfg. Co., Gasport, N. Y.
Frost Insecticide Co., Arlington, Mass.
Hardie Mfg. Co., Hudson, Mich.
Hudson, H D., Mfg. Co., 589 E. Illinois St., Chicago, Ill.
Myers, F. E., & Bro. Co., Ashland, Ohio.
Niagara Sprayer & Chemical Co., Inc., Middleport, N. Y.
Universal Power Sprayer Co., Inc., Plymouth, Mich.
Western Fire Equipment Co., 69 Main St., San Francisco, Calif.
Wilson, Andrew, Inc., Springfield, N. J.

E. LABORATORY EQUIPMENT:

General:

Carpocapsa, 375 Lehigh Ave., East Liberty Sta., Pittsburgh, Pa.
Clay-Adams Co., 44 East 23rd St., New York, N. Y.
Daigger, A., & Co., 159 West Kinsie St., Chicago, Ill.
Dennoyer-Geppert Co., 5235 Ravenwood Ave., Chicago, Ill.
General Biological Supply House, Inc., 761 East 69th Place, Chicago, Ill.
New York Scientific Supply Co., 28 West 30th St., New York, N. Y.
Phipps and Bird, Inc., Richmond, Va.
Southern Biological Supply Co., Inc., 517 Decatur St., New Orleans, La.
Standard Scientific Supply Corp., 34 West 4th St., New York, N. Y.
Ward's Natural Science Establishment, Inc., 3000 Ridge Rd., P. O. Box 24, Beechwood Station, Rochester 8, N. Y.

Special:

Arrow Products Co., 477 Lincoln St., Carlstadt, N. J.
Bausch & Lomb Optical Co., Rochester, N. Y.; 5 N. Wabash, Chicago, Ill.
Braun-Knecht-Heimann Co., 1400 16th St., San Francisco, Calif.
Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.
Corning Glass Works, Corning, N. Y.
Eimer & Amend, 635 Greenwich St., New York, N. Y.
Fisher Scientific Co., 709 Forbes St., Pittsburgh, Pa.
General Biological, 761 East 69 Place, Chicago, Ill.
General Machine Co., 398 Market St., Newark, N. J.
Greiner, Emil, Co., 55 Fulton St., New York, N. Y.
Heil Corp., 210 South Fourth St., St. Louis, Mo.
Kauffman-Lattimer Co., 263 North Front St., Columbus, Ohio.
Macalaster Bicknell Co., Cambridge, Mass.
Mine & Smelting Supply Co., 225 Broadway, New York, N. Y.
National Scientific Corp., 814 N. Franklin St., Chicago, Ill.
New York Scientific Supply Co., 28 West 30th St., New York, N. Y.
Ohio Chemical & Mfg. Co., 1177 Marquette St., N.E., Cleveland, Ohio.
Palo-Myers, Inc., 81 Reade St., New York 7, N. Y.
Schaar & Co., 754 W. Lexington St., Chicago 7, Ill.
Sorvall, Ivan, 210 Fifth Ave., New York 10, N. Y.
Taylor Instrument Companies, Rochester, N. Y.
Ward's Natural Science Establishment, Inc., P. O. Box 24, Rochester, N. Y.
Welch Scientific Apparatus Co., Chicago, Ill.
Wilkins-Anderson Co., 111 N. Canal St., Chicago 6, Ill.

Microscopes:

American Optical Co., Buffalo, N. Y.
Bausch & Lomb Optical Co., Rochester, N. Y.
Central Scientific Co., Chicago, Ill.
Clay-Adams Co., 25 East 26th St., New York, N. Y.
Daigger, A., & Co., 159 West Kinzie St., Chicago, Ill.
Dennoyer-Geppert Co., 5235 Ravenwood Ave., Chicago, Ill.
Eimer-Amend, 18th St. & 3rd Ave., New York, N. Y.
Fisher Scientific Co., 709 Forbes St., Pittsburgh, Pa.
General Biological Supply House, Inc., 761 East 69th Place, Chicago, Ill.
Leitz, E., Inc., 60 East 10th St., New York, N. Y.
New York Biological Supply Co., 34 Union Sq., New York, N. Y.
New York Scientific Supply Co., 28 West 30th St., New York, N. Y.
Spencer Lens Co., Buffalo, N. Y.
Standard Scientific Supply Corp., 34 West 4th St., New York, N. Y.
Thomas, Arthur H., Washington Sq., Philadelphia, Pa.
Ward's Natural Science Establishment, Inc., P. O. Box 24, Rochester, N. Y.
Zeiss, Carl, Inc., 485 Fifth Ave., New York, N. Y.

Traps, Mosquito:

Hausheer's Machine Works, Bayville, N. J.
Lincoln Mfg. Co., New Brunswick, N. J.

F. LARVICIDES AND RELATED CHEMICALS:

Activators and Synergists:

Wilmington Atlas Powder Co., Wilmington 99, Del. "NNO".
Dodge & Olcott, 180 Varick St., New York 14, N. Y.
Hercules Powder Co., 984 Market St., Wilmington, Del. "DHS".
Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo.
Pearson-Ferguson Chemical Co., 1400 Union Ave., Kansas City 7, Mo.
Powell, John & Co., Inc., 1 Park Ave., New York, N. Y.
Velsicol Corp., 120 East Pearson St., Chicago 11, Ill.

Aerosols:

Aerosols, Inc., Neodesha, Kans.
Armstrong Engineering Co., 29 Broadway, New York, N. Y.
Bridgeport Brass Co., Bridgeport, Conn.
Industrial Management Corp., Aerosol Insecticide Division, 639 Spring St., Los Angeles, Calif.
Industrial Manufacturing Co., Valparaiso, Ind.
Knapp Monarch Co., St. Louis, Mo.
Pennsylvania Engineering Co., 1119 N. Harvard St., Philadelphia, Pa.
Regal Chemical Corp., Brooklyn, N. Y.
Westinghouse Electric Corp., 633 Page Blvd., Springfield, Mass.

Cresols and Cresylic Acid:

American-British Chemical Supplies, Inc., 180 Madison Ave., New York, N. Y.
Barrett Co., 40 Rector St., New York, N. Y.
California Spray-Chemical Corp., Richmond, Calif.
Good, James, Co., 2114 East Susquehanna Ave., Philadelphia, Pa.
Miller Products Co., 1932 S. W. Water Ave., Portland 1, Ore.
Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis 4, Ind.

D.D.T.:

American Cyanamid and Chemical Corp., 32C Rockefeller Plaza, New York 20, N. Y.
American Home Products Co., Marietta, Ohio.
Baker, J. T., Chemical Co., Phillipsburg, N. J.
Boyle-Midway, Inc., New York, N. Y.
Braun-Knecht Heimann Co., 1400 16th St., San Francisco, Calif.
Butcher, L. H., Co., 15th & Vermont Sts., San Francisco, Calif.
Chemurgic Corp., Richmond, Calif.
Cincinnati Chemical Works, Norwood, Ohio.
Dow Chemical Co., 135 S. La Salle, Chicago, Ill.
duPont, E. I., de Nemours, Grasselli Chemical Dept., Wilmington 98, Del.
Elko Chemical Works, 60 East 42nd St., New York 8, N. Y.
Gaby Co., Philadelphia, Pa.
Geigy & Co., 8 Barclay St., New York 8, N. Y.
General Chemical Co., 40 Rector St., New York 6, N. Y.
Hercules Powder Co., Wilmington 99, Del.
Hooker Electrochemical Co., Echota Station, Niagara Falls, N. Y.
Linck, O. E., Co., Inc., 51 James St., Montclair, N. J.
McConnon & Co., Winona, Minn.
McCormick & Co., Inc., Baltimore 2, Md.
McLaughlin Gormley King Co., Minneapolis, Minn.
Merck & Co., Rahway, N. J.
Michigan Chemical Corp., St. Louis, Mich.
Miller Chemical & Fertilizer Co., 1000 S. Caroline St., Baltimore 31, Md.
Monsanto Chemical Co., 1700 South 2nd St., St. Louis 4, Mo.
Montrose Chemical Co., Newark, N. J.
Naugatuck Chemical Co., Naugatuck, Conn.
Nico-Dust Mfg. Co., Div. of Stauffer Chemical Co., 636 California St., San Francisco 8, Calif.
Pennsylvania Salt Mfg. Co., Widener Bldg., Philadelphia 7, Pa.
Parma Chemical Corporation, 175 Fifth Ave., New York 10, N. Y.
Sherwin-Williams Co., 101 Prospect Ave., Cleveland, Ohio.
United States Rubber Co., Elm St., Naugatuck, Conn.
Westvaco Chlorine Products Corp., 405 Lexington Ave., New York 17, N. Y.

Diluents and Carriers:

American Colloid Co., 363 West Superior St., Chicago 10, Ill.
American Cyanamid and Chemical Corp., 32C Rockefeller Plaza, New York 20, N. Y.
American Lime & Stone Co., Bellefonte, Pa.
Attapulgus Clay Co., 260 S. Broad St., Philadelphia 1, Pa.
Carbola Chemical Co., Inc., Natural Bridge, N. Y.
California Spray-Chemical Corp., Richmond, Calif.
Carolina Pyrophyllite Co., 10 East 40th St., New York 16, N. Y.
Chemurgic Corp., Giant Rd., Richmond, Calif.
Clinchfield Sand and Feldspar Corp.. 618 Mercantile Bldg., Baltimore, Md.
Doggett-Pfeil Co., Springfield, N. J.
Drury, A. C., & Co., 219 E. North Water St., Chicago, Ill.
Eastern Magnesia Talc Co., Inc., Burlington, Vt.
Floridin Co., Warren, Pa.
Innis Speiden & Co., 117 Liberty St., New York, N. Y.
Haden Lime Co., Houston, Tex.
Hammill & Gillespie, Inc., 225 Broadway, New York, N. Y.
Miller Products Co., 1932 S. W. Water Ave., Portland 1, Ore.
Moreland Chemical Co., Spartansburg, S. C.
Pacific Coast Talc Co., 2149 Bay St., Los Angeles, Calif.
Planters Chemical Co., 88 Church St., Norfolk 10, Va.
Sherwin-Williams Co., 101 Prospect Ave., Cleveland, Ohio.
United Clay Mines Corp., Prospect & Oakland Sts., Trenton, N. J.
Vanderbilt, R. T., Co., Inc., 230 Park Ave., New York 17, N. Y.
Whittaker, Clark & Daniels, Inc., 260 Broadway, New York, N. Y.
Williams, C. K., & Co., 640 N. 13th St., Easton, Pa.

Emulsifying Agents:

Allaire Woodward Co., 444 W. Grand Ave., Chicago, Ill.
American Colloid Co., 363 W. Superior St., Chicago, Ill.
Atlas Powder Co., Wilmington 99, Del.
California Spray-Chemical Corp., Richmond, Calif.
Carbide and Carbon Chemicals Corp. 30 East 42nd St., New York 17, N. Y.
Colgate Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J.
Colgate Palmolive-Peet Co., Carleton & 6th St., Berkeley, Calif.
Dodge and Olcott Co., 180 Varick St., New York 14, N. Y.
duPont, E. I., de Nemours & Co., Inc., Wilmington 98, Del. "Duponol".
General Dyestuff Corp., 435 Hudson St., New York 14, N. Y. "Igepal", "Emulphor".
Hercules Powder Co., 984 Market St., Wilmington, Del.
Monsanto Chemical Co., 1700 South 2nd St., St. Louis 4, Mo.
Niagara Sprayer and Chemical Co., Inc., Middleport, N. Y.
Rohm & Haas Co., Washington Sq., Philadelphia 5, Pa.; 930 N. Halstead St., Chicago, Ill. "Tritons".
Sonneborn, L., Sons, Inc., 88 Lexington Ave., New York 16, N. Y.
Standard Agricultural Chemicals, Inc., 1301 Jefferson St., Hoboken, N. J. "Stantex".
Velsicol Corp., 120 East Pearson St., Chicago 11, Ill.
Wolf, Jacques, & Co., Passaic, N. J.

Mosquito Larvicides:

Baird & McGuire, Inc., Holbrook, Mass.
California Spray-Chemical Corp., Richmond, Calif.
Chipman Chemical Co., Inc., Bound Brook, N. J.
Chemical Supply Co., 2450 Canal Rd., Cleveland, Ohio.
Chemurgic Corp., Giant Rd., Richmond, Calif.
Chicago Sanitary Products Co., 3100 S. Throop St., Chicago, Ill.
Clifton Chemical Co., 247 Front St., New York, N. Y.
Creco Co., Inc., Creco Bldg., Long Island City, N. Y.
Crystal Soap & Chemical Co., 6300 State Rd., Tacony, Philadelphia, Pa.
Doggett-Pfeil Co., Springfield, N. J.
Dow Chemical Co., Midland, Mich.
Eagle Soap Corp., Huntington, Ind.
Fuld Bros., 2308 Fredrick Ave., Baltimore, Md.
Hercules Powder Co., Wilmington, Del.
Hockwald Chemical Co., 30 Bluxome St., San Francisco, Calif.

Mosquito Larvicides—(Continued)

Hysan Products Co., 2560 Armitage Ave., Chicago, Ill.
Koppers Co., White Tar Div., Kearny, N. J.
Linck, O. E., Inc., 51 James St., Montclair, N. J.
Marshall Products, Inc., 806 North First St., St. Louis, Mo.
McCormick Sales Co., Inc., Baltimore, Md.
Merck & Co., Inc., Rahway, N. J.
Michel & Pelton Co., 5743 Landregan St., Oakland, Calif.
North Coast Chemical & Soap Works, Seattle, Wash.
Palmer Products, Inc., Waukesha, Wis.
Pratt, B. G., Co., 50 Church St., New York, N. Y.
Seacoast Laboratories, Inc., 156 Perry St., New York, N. Y.
Sonneborn, L., & Sons, 88 Lexington Ave., New York, N. Y.
U. S. Sanitary Specialties Corp., 435 South Western Ave., Chicago, Ill.
White Tar Co. of N. J., Kearny, N. J.
Velsicol Corp., 120 East Pearson St., Chicago 11, Ill.
Wilson, Andrew, Inc., Springfield, N. J.
Woods, Frank Z., 444 W. Grand Ave., Chicago, Ill.

Oils:

American Mineral Spirits Co., 230 N. Michigan Ave., Chicago, Ill.
Anderson-Prichard Oil Corp., Oklahoma City, Okla.
Doggett-Pfeil Co., Springfield, N. J.
Gulf Oil Corp., Gulf Refining Co., Gulf Bldg., Pittsburgh, Pa.
Lake-Cook Farm Supply Co., 977 Lee St., Des Plaines, Ill.
MacMillan Petroleum Corp., 624 S. Michigan, Chicago, Ill.
Magnus, Mabee & Reynard, Inc., 16 Des Brosses St., New York 13, N. Y.
Pennsylvania Grade Crude Oil Assn., Oil City, Pa.
Pennsylvania Refining Co., Butler, Pa.
Pure Oil Corp., 35 E. Wacker Drive, Chicago 1, Ill.
Red Feather Oil Co., Salt Lake City, Utah.
Seacoast Laboratories, Inc., 156 Perry St., New York 14, N. Y.
Shell Oil Co., Inc., 50 West 50th St., New York 20, N. Y.
Sinclair Refining Co., East Chicago, Ill.
Standard Oil Co. (Calif.), 225 Bush St., San Francisco, Calif.
Standard Oil Co. (Calif.), 910 Michigan Ave., Chicago 80, Ill.
Standard Oil Co. (N. J.), 26 Broadway, New York, N. Y.
Sun Oil Co., 420 Lexington Ave., New York, N. Y.
Texas Co., 135 East 42nd St., New York, N. Y.
Tidewater Oil Co., 17 Battery Pl., New York, N. Y.
Union Oil Co. of California, 617 West 7th St., Los Angeles 14, Calif.
Velsicol Corp., 120 East Pearson St., Chicago 11, Ill.
Wells Petroleum Co., 816 W. Haines, Chicago, Ill.
Wilson, Andrew, Inc., Springfield, N. J.

Paris Green:

Acme White Lead & Color Works, 8250 St. Aubin Ave., Detroit, Mich.
Bird, William M., & Co., Inc., Charleston, S. C.
California Spray-Chemical Corp., Richmond, Calif.
Chipman Chemical Co., Inc., Bound Brook, N. J.
Dow Chemical Co., Midland, Mich.
duPont, E. I., de Nemours & Co. (Inc.), Wilmington 98, Del.
Florida Insecticide Co., Inc., Apoka, Fla.
General Chemical Co., 40 Rector St., New York, N. Y.
Goulard & Olena, 140 Liberty St., New York, N. Y.
Los Angeles Chemical Co., 1960 Santa Fe Ave., Los Angeles, Calif.
Miller Chemical & Fertilizer Corp., 1000 South Caroline St., Baltimore 31, Md.
Nico-Dust Mfg. Co., Div. of Stauffer Chemical Co., 636 California St., San Francisco 8, Calif.
Peaslee-Gaulbert Corp., 226 N. 15th St., Louisville, Ky.
Sherwin-Williams Co., 101 Prospect Ave., Cleveland, Ohio.
Vaughan Seed Co., 601 W. Jackson, Chicago, Ill.

Pyrethrum Products:

Agicide Laboratories, Racine, Wis.
Allaire, Woodward & Co., Peoria, Ill.; 444 W. Grand Ave., Chicago, Ill.
An-Fo-Mfg. Co., 3129 Elmwood Ave., Oakland 1, Calif.
Bartlett Chemicals, Inc., 1460 So. Peters St., New Orleans, La.
California Spray-Chemical Corp., Richmond, Calif.
Dodge & Olcott Co., 180 Varick St., New York, N. Y.
Doggett-Pfeil Co., Springfield, N. J.
Hector Supply Co., Miami, Fla.
McCormick & Co., Inc., Baltimore 2, Md.
McLaughlin Gormley King Co., 1715 Fifth St., S.E., Minneapolis, Minn.
Penick & Co., S. B., 50 Church St., New York 7, N. Y.
Powell, John, & Co., Inc., 1 Park Ave., New York, N. Y.
Pratt, B. G., Co., 160 Moore St., Hackensack, N. J.
Prentiss, R. J., & Co., 80 John St., New York 7, N. Y.
Seacoast Laboratories, Inc., 156 Perry St., New York 14, N. Y.
Thompson-Hayward Chemical Co., 29th and Southwest Blvd., Kansas City, Mo.

Repellents:

Aicken Corp., New York, N. Y.
American Cyanamid & Chemical Corp., 32C Rockefeller Plaza, New York 20, N. Y.
Becker-Bischoff Chemical Co., 3804 W. Pine Blvd., St. Louis 8, Mo. "Jitter Bug."
Bonide Chemical Co., Inc., Utica, N. Y.
Cenol Co., 4250 N. Crawford Ave., Chicago, Ill.
Doggett-Pfeil Co., Springfield, N. J. "Repellit."
Hanley Kinsella Laboratories, Inc., St. Louis, Mo.
Hubere Cosmetics, Chicago 6, Ill.
McKesson & Robbins, Inc., 50 First St., San Francisco, Calif.; 3rd Ave., New York, N. Y.
Monsanto Chemical Co., 1700 South 2nd St., St. Louis 4, Mo.
National Carbon Co., 30 East 42nd St., New York 17, N. Y.
Nott Mfg. Co., Mt. Vernon, N. Y. "Skeet-check".
Skol Co., Inc., 250 West 43rd St., New York, N. Y. "Skat."
Sparhawk Company, Sparkill, N. Y.
Stanco, Inc., 2 Park Ave., New York, N. Y.
United Drug Co., Boston, Mass.; St. Louis, Mo.
U. S. Industrial Chemicals, Inc., 60 East 42nd St., New York, N. Y.
Velsicol Corp., 120 East Pearson St., Chicago 11, Ill.

Soaps:

California Spray-Chemical Corp., Richmond, Calif.
Chemical Supply Co., 225 Plymouth Bldg., Clevaland, Ohio.
Chicago Sanitary Products Co., 3100 S. Throop St., Chicago 8, Ill.
Colgate, Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J.
Crystal Soap & Chemical Co., 6300 State Rd., Tacony, Philadelphia 35, Pa.
Doggett-Pfeil Co., Springfield, N. J.
Eagle Soap Corp., Huntington, Ind.
Good, James, Co., 2114 E. Susquehanna Ave., Philadelphia 25, Pa.
Seacoast Laboratories, Inc., 156 Perry St., New York, N. Y.
Standard Agricultural Chemicals, Inc., 1301 Jefferson St., Hoboken, N. J.
Wilson, Andrew, Inc., Springfield, N. J.

Solvents:

Advance Solvents & Chemical Corp., 245 Fifth Ave., New York, N. Y.
Alabama By-Products Co., Tarrant, Ala. (Xylene.)
American Cyanamid & Chemical Corp., 32C Rockefeller Plaza, New York 20, N. Y.
Anderson-Prichard Oil Corp, Oklahoma City 2, Okla.
Carbide and Carbon Chemicals Corp., 30 East 42nd St., New York 17, N. Y.
Doggett-Pfeil Co., Springfield, N. J.
Elk, B. R., & Co., Inc., Garfield, N. J. (Xylene.)
Monsanto Chemical Co., 1700 South 2nd St., St. Louis 4, Mo.
Pennsylvania Refining Co., Butler, Pa.
Powell, John, & Co., Inc., 1 Park Ave., New York, N. Y.
Sloss-Sheffield Steel & Iron Co., Birmingham, Ala.
Socony-Vaccum Oil Co., 26 Broadway, New York, N. Y.

Solvents—(Continued)

Sonneborn, L., Sons, Inc., 88 Lexington Ave., New York 16, N. Y.
Standard Oil Co. of N. J., Bayway, N. J. "Solvesso", "Mentor".
Sun Oil Co., Philadelphia 3, Pa. "Aro-Sol".
Velsicol Corp., 120 East Pearson St., Chicago 11, Ill.

Weed Killers:

Acteen Chemical Service Co., 2nd & Addison Sts., Berkeley, Calif.
American Chemical Paint Co., Ambler, Pa.
California Spray-Chemical Corp., Richmond, Calif.
Chipman Chemical Co., Inc., Bound Brook, N. J.
Doggett-Pfeil Co., Springfield, N. J.
Dow Chemical Co., Midland, Mich.
Florida Insecticide Co., Inc., Apoka, Fla.
Koppers Co., Tar & Chemicals Div., Koppers Bldg., Pittsburgh, Pa.
Miller Products Co., 1932 S. W. Water St., Portland 1, Ore.
Pennsylvania Salt Mfg. Co., Widener Bldg., Philadelphia 7, Pa.
Standard Agricultural Chemicals, Inc., 1301 Jefferson St., Hoboken, N. J.

G. MARINE EQUIPMENT:

Boats:

Acme Mfg. Co., Miamisburg, Ohio.
Barbour Metal Boat Works, Valley Park, Mo.
Clark Folding Boat Co., 105 Dew Hollow Rd., San Francisco, Calif.
Columbia Steel Tank Co., Kansas City 7, Mo.
Darrow Steel Boat Co., Albion, Mich.
Folbot Corp., 42–09 Hunter, Long Island City, N. Y.
Fellowcrafters, Inc., 62 Stanhope, Boston, Mass.
Kalamazoo Canvas Boat Co., Kalamazoo, Mich.
Kennebec Boat & Canoe Co., Waterville, Me.
Kidney, Daniel, & Son, West De Pere, Wis.
Marine Craft & Mfg. Co., of America, 72 West 13th, Chicago, Ill.
New York Rubber Corp., New York, N. Y.
Old Town Canoe Co., Old Town, Me.
Prigg Boat Co., Miami, Fla.
Skowhegan Boat & Canoe Co., Norridgewock, Me.
Star Metal Boat Co., Goshen, Ind.
Thomson Bros. Boat Mfg. Co., Peshtigo, Wis.

Motors, Boat Inboard:

Bridgeport Motor Co., Inc., 386 Montain Grove, Bridgeport, Conn.
Briggs & Stratton Corp., 2711 North 13th St., Milwaukee, Wis.
Kermath Mfg. Co., 5882 Commonwealth Ave., Detroit, Mich.
Lauson Co., New Holstein, Wis.
Palmer Bros. Engines, Inc., Cos Cob, Conn.
Peerless Marine Motor Corp., 2150 Niagara, Buffalo, N. Y.
Red Wing Motor Co., Red Wing, Minn.
Regal Mfg. Co., Pearl & Monroe, Coldwater, Mich.
Standard Gas Engine Co., 1126 6th Ave., Oakland, Calif.
United States Motor Co., 317 Universal Drive, Oshkosh, Wis.
Wisconsin Motor Corp., 1910 South 53rd St., Milwaukee, Wis.

Motors, Boat Outboard:

Caille Motor Co., 6210 2nd Ave., Detroit, Mich.
Champion Motors Co., Minneapolis, Minn.
Detroit Outboard Products Corp., 23700 Mack Ave., St. Clair Shores, Mich.
Elto Motors, 4939 North 27th St., Milwaukee, Wis.
Evinrude Motors, 4464 North 27th St., Milwaukee, Wis.
Gale Products, Galesburg, Ill.
Johnson Motors, 1820 Pershing Rd., Waukegan, Ill.
Kiekhaefer Corp., Webster Ave., Cedarburg, Wis.
Lauson Co., New Holstein, Wis.
Muncie Gear Co., Muncie, Ind.
Outboard Motors Corp., 4464 North 27th St., Milwaukee, Wis.

Marine Supplies:

Adams & Westlake Co., Chicago, Ill.
Bonney Forge & Tool Works, Allentown, Pa.
Budd, Edward G., Mfg. Co., 25 Hunting Park Ave., Philadelphia, Pa.
Climax, J. H. W., Co., 87 Clay St., Newark, N. J.
Corbin, P. & F., New Britain, Conn.
Dent, Hardware Co., Fullerton, Pa.
Eberhard Mfg. Co., Div. Eastern Malleable Iron Co., 2734 Tennyson Rd., S.E., Cleveland, Ohio.
Evinrude Motors, 5901 W. Madison, Chicago, Ill.
Fiwale Equipment Mfg. Co., 64 Reade, New York, N. Y.
Getty, H. S., & Co., Inc., 3348 North 10th, Philadelphia, Pa.
Independent Foundry Co., Portland, Me.
Keil, Francis, & Son, Inc., 401 East 163rd St., New York, N. Y.
Laughlin, Thomas, Co., 199 Fore St., Portland, Me.
Maine Steel, Inc., South Portland, Me.
Malleable Iron Fittings, Inc., 10 Nichols, Branford, Conn.
Masters, W. L., & Son, 210 W. Chicago, Chicago, Ill.
Merrill Bros., Maspeth, N. Y.
Metropolitan Bronze Mfg. Corp., 92–32 Union Hall, Jamaica, Long Island, N. Y.
Miller Marine Co., 357 State, Perth Amboy, N. J.
Norwalk Lock, 395 Broadway, New York, N. Y.
Paxton Co., 64 Commercial Place, Norfolk 10, Va.
Perkins Marine Lamp Corp., 1943 Perkins Ave., Brooklyn, N. Y.
Phoenix Lock Works, 3rd Ave., Newark, N. J.
Rostand Mfg. Co., Milford, Conn.
Russell & Erwin Mfg. Co., New Britain, Conn.
Safe Padlock & Hardware Co., Lancaster, Pa.
Sargent & Co., New Haven, Conn.
Slaymaker Lock Co., Lancaster, Pa.
Torrey Roller Bushing Works, Bath, Me.
Wilcox, Crittenden & Co., Inc., 77 S. Main, Middletown, Conn.
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